COVIDIEN

Service Manual

Puritan Bennett™

560 Ventilator

COVIDIEN Puritan Bennett 560 Ventilator
FiO2

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While the information set forth herein is believed to be accurate, it is not a substitute for the exercise of professional judgment.

The ventilator should be operated and serviced only by trained professionals. Covidien's sole responsibility with respect to the ventilator, and its use, is as stated in the limited warranty provided.

Nothing in this manual shall limit or restrict in any way Covidien's right to revise or otherwise change or modify the equipment (including its software) described herein, without notice. In the absence of an express, written agreement to the contrary, Covidien has no obligation to furnish any such revisions, changes, or modifications to the owner or user of the equipment (including its software) described herein.

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Preface

About this Manual

This manual provides information needed to service the Puritan Bennett™ 520 Ventilator. This manual is intended for use by factory-trained biomedical engineering technicians or personnel with equivalent experience and training in servicing this type of equipment. It is recommended that the user complete the Puritan Bennett™ 520 Ventilator training class.

Note:

This manual is written assuming English (US) language is selected in ventilator SETUP (Section 2.12). Ventilator messages will be different depending upon the language selected.

While this manual covers the ventilator configurations currently supported by Covidien, it may not be all-inclusive and may not be applicable to your ventilator. You should ensure you have the most current applicable version of this manual; if in doubt, contact Covidien or visit the Puritan Bennett product manual web page at: http://covidien.com/rms/sales-support/product-manuals. Contact your local representative for questions regarding the applicability of the information.

Qualification of Personnel

Installation and maintenance of the device must be made by authorized and trained personnel. In particular, training for the handling of products sensitive to electrostatic discharges must include the use of Electrostatic Discharge (ESD) protection devices and knowledge of the ESD symbol's meaning, as well as using original spare parts and respecting quality assurance and traceability rules approved by Covidien.

Electromagnetic Susceptibility

The Puritan Bennett™ 520 Ventilator complies with the requirements of IEC 60601-1-2:2007 (EMC Collateral Standard), including the E-field susceptibility requirements at a level of 20 volts per meter at frequencies up to 1 GHz, and 10 volts per meter at frequencies between 1 GHz and 2.5 GHz, and the ESD requirements of this standard. However, even at this level of device immunity, certain transmitting devices (cellular phones, walkie-talkies, cordless phones, paging transmitters, etc.) emit radio frequencies that could interrupt ventilator operation if located in a range too close to the ventilator. It is difficult to determine when the field strength of these devices becomes excessive.

Practitioners should be aware that radio frequency emissions are additive, and that the ventilator must be located a sufficient distance from transmitting devices to avoid interruption. Do not operate or store the ventilator in the presence of strong electromagnetic fields such as a magnetic resonance imaging (MRI) environment. Chapter 4 describes possible ventilator alarms and what to do if they occur. Contact an authorized service representative or you local durable medical equipment (DME) representative in case of interrupted ventilator operation and before relocating any life support equipment.

WARNING

Accessory equipment connected to the power receptacle, analog, and digital interfaces must be certified according to IEC 60601-1. Furthermore, all configurations shall comply with the system standard IEC 60601-1-1. Any person who connects additional equipment to the power receptacle, signal input part, or signal output part of the Puritan Bennett™ 520 Ventilator configures a medical system, and is therefore responsible for ensuring that the system complies with the requirements of the system standard IEC 60601-1-1. If in doubt, consult Puritan Bennett Technical Support at 1.800.255.6774 or your local representative.

Warranty

Information regarding your product warranty is available from your sales representative or Covidien.

Extended Service

The Puritan Bennett™ 560 Ventilator offers extended service contracts/warranties for purchase when the ventilator is purchased. Please contact your local Covidien sales or service representative for additional information.

Customer Assistance

For online technical support, visit the SolvIT^{SM} Center Knowledge Base by clicking the link at www.medtronic.com/covidien/support/solvit-center-knowledge-base/. Here, you will find answers to frequently asked questions about the Puritan Bennett™ 520 Ventilator, and other Puritan Bennett products 24 hours a day, 7 days a week. For troubleshooting help or to obtain service for your ventilator, call your local Puritan Bennett Technical Support center. If you require further assistance, contact your local Puritan Bennett representative.

Year of Manufacture

The year of manufacture for ventilators is indicated on the bottom of the ventilator as shown here.

2007

Manufacturer

The manufacturer and authorized representative are shown below.

Covidien llc
15 Hampshire Street
Mansfield, MA 02408

EC REP Covidien Ireland Limited, IDA Business & Technology Park, Tullamore.

Service Centers

The following table lists Covidien international service centers.

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Covidien Belgium BVBA/SPRL Generaal De Wittelaan 9/5 2800 Mechelen Belgium Tel: +32 220 08260 Fax: +32 270 06690	**Covidien Brazil** Praça Agrícola La Paz Tristante, 121 Osasco – São Paulo / CEP 06276-035 São Paulo, SP Brasil 04578-000 Tel: +55 11 2187 6543 Fax: 2187 6380	**Covidien Canada** 19600 Clark Graham Baie d'Urfe, QC, H9X 3R8 Canada Tel: 1 877 664 8926, option 2 Fax: 1 514 695 7534	**Covidien Chile** Lo Boza 107 Pudahuel Santiago Chile Tel: 562 2739 3000 Fax: 562 783 3149
Covidien China 1st Floor, Covidien Plaza, Building 14 No. 99 Tian Zhou Rd CAOHEJING High Tech Park Xu Hui District Shanghai 200233 P.R. China Tel: +86 4008 21 6699 Fax: +86 2154 4511 18	**Covidien Colombia** Edificio Prados de la Morea Carretera Central Del Norte (Cra 7a) Kilometro 18, Chia-Cundinamarca Bogota, Colombia Tel: 571 668 3777 Fax: 571 668 3777,ext. 181	**Covidien Costa Rica** Global Park, Parkway 50 La Auroa de Heredia 40104 Costa Rica Tel: 506 2293 4854 Fax: 506 2239 9108	**Covidien ECE s.r.o.** Organizacní Složka Prosek, Prosecká 852/66 190 00 Praha 9 Tel: +420 241 095 735 Fax: +420 239 016 856
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Table 1-1. Covidien Service Centers (Continued)

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Covidien Norge AS Postboks 343 N1372 Askerr Norway Tel: +47 2415 9887 Fax: +47 2302 4955	**Covidien Panama** Parque Industrial Costa del Esta Calle Primera, Edifio #109 Panama City, Panama Tel: 507 264 7337 Fax: 507 236 7408	**Covidien Polska** Al. Jerozolimskie 182 02-222 Warszawa Polska Tel: +48 22 279 04 05 Fax: +48 22 279 04 03	**Covidien Portugal Lda.** Estrada do Outeiro de Polima, Lote 10-1° Piso Abóboda 2785-521 S.Domingos de Rana Portugal Tel: +35 21 761 62 44 Fax: +35 800 781385
Covidien Puerto Rico Palmas Industrial Park Road 869 Km 2.0 Bdlg. #1 Cataño, PR 00962 Tel: 787 993 7250 Ext. 7222 & 7221 Fax: 787-993-7234	**Covidien Russia** 53 bld. 5 Dubininskaya Street Moscow Russia 119054 Tel: +70 495 933 64 69 Fax: +70 495 933 64 68	**Covidien Saglik A.S.** Maslak Mahallesi Bilim Sokak No: 5, Sun Plaza Kat: 2-3 Sisli, Istanbul 34398 Turkey Tel: +90 212 366 20 00 Fax: +90 212 276 35 25	**Covidien South Africa** Corporate Park North 379 Roan Crescent Randjespark Midrand, South Africa Tel: +27 115 429 500 Fax: +27 115 429 624
Covidien Spain S.L. Servicio Técnico WTC Almeda Park Plaça de la Pau, S/N - Edif. 7, 3ª Planta 08940 Cornellá de Llobregat Barcelona, Spain Tel: +34 91 275 48 54 (option 3) Fax: +34 91 276 89 33	**Covidien Sverige AB** Box 54 17174 Solna Sweden Tel: +46 8 517 615 73 Fax: +46 8 502 521 10	**Covidien Switzerland** Roosstrasse 53 8832 Wollerau Schweiz Tel: +41 44 511 82 71 Fax: +4144 511 16 34	**Covidien Thailand** 99 Soi Rubia, Sukhumvit 42 Road 13 - 14 Fl., Berli Jucker Building Prakanong, Klongtoey Bangkok 10110, Thailand Tel: +662 2073- 100 Fax: +662 657 6325
Covidien UK Unit 2, Talisman Business Park London Road, Bicester OX26 6HR, United Kingdom Tel: +4420 3027 1757 Fax: +4420 3684 8869	**Covidien USA** 2101 Faraday Ave Carlsbad, CA 92008 Tel: 1 800 255 6774 (option 4) Email: VentTechSupport@covidien.com		

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1 Safety Information

1.1 Definitions

This manual uses three indicators to highlight critical information: Warning, Caution, and Note. They are defined as follows:

WARNING

Indicates a condition that can endanger the patient or the ventilator operator.

Caution

Indicates a condition that can damage the equipment.

Note:

Indicates points of particular emphasis, that make operation of the ventilator more efficient or convenient.

Please take the time to familiarize yourself with the following caveats as they cover safety considerations, special handling requirements, and regulations that govern the use of the Puritan Bennett™ 520 Ventilator.

1.2 Warnings

Fire Hazard Warnings

- **To avoid a fire hazard, keep matches, lighted cigarettes, and all other sources of ignition (e.g., flammable anesthetics and/or heaters) away from the ventilator and oxygen hoses.**
- **In case of fire or a burning smell, immediately disconnect the ventilator from the oxygen supply, facility power, and battery.**
- **Do not use oxygen hoses that are worn, frayed, or contaminated by combustible materials such as grease or oils. (Textiles, oils, and other combustibles are easily ignited and burn with great intensity in air enriched with oxygen.)**
- **The ventilator must not be used with flammable anesthetic substances.**
- **Never expose any batteries to direct flame.**

Warnings for General Repair Safety

- **To ensure proper servicing and avoid the possibility of physical injury, only qualified personnel should attempt to service or make authorized modifications to the ventilator.**
- **To avoid an electrical shock hazard while servicing the ventilator, be sure to remove all power to the ventilator by disconnecting the power source and turning off all ventilator power switches before servicing. Follow accepted safety practices for electrical equipment when testing or making equipment adjustment, or repairs.**
- **When replacing the ventilator's internal battery, the ventilator must be disconnected from all external power supplies and turned off.**
- **When servicing the ventilator, be sure to familiarize yourself with, and adhere to all posted and stated safety warning and caution labels on the ventilator and its components, and on any service equipment and materials used. Failure to adhere to such warnings and cautions at all times may result in injury or property damage.**
- **To prevent personal injury or death, do not attempt any ventilator service while a patient, or other person, is connected to the ventilator.**
- **Never touch the ventilator's internal components, including the battery, and the patient simultaneously.**
- **To ensure proper performance of the ventilator, follow the preventive maintenance schedule listed in Table 2-15.**
- **To prevent possible personal injury, always disconnect the oxygen source from the ventilator before service.**
- **Use all cleaning solutions and products with caution. Read and follow the instructions associated with the cleaning solutions you use to clean your ventilator. Use only those solutions listed in Table 2-14.**
- **Do not clean any gas pathway with a liquid cleaner. Refer to Table 2-14 for allowable cleaning and disinfecting agents for use on other parts of the ventilator.**
- **Use personal protective equipment whenever exposure to toxic fumes, vapor, dust particles, blood pathogens, and other transmittable diseases and hazardous material can be expected. If in doubt, consult an environmental health and safety specialist or an industrial hygienist before servicing the ventilator. Refer to Section 5.6.1 for cleaning procedure.**
- **Chemicals from a broken LCD panel are toxic when ingested. Use caution when handling a ventilator with a broken display panel.**
- **To prevent possible damage to the power supply, remove the battery from the ventilator (Section 5.7.4) during disassembly and reassembly.**

Warnings about Reducing Infection

- **To reduce the risk of infection, wash your hands thoroughly before and after handling the ventilator or its accessories.**

- **Dirty or contaminated equipment is a potential source of infection. Clean the ventilator and its accessories regularly and systematically before and after each use and following any maintenance procedure to reduce the risks of infection. The use of a bacteria filter at the ventilator's outlet — or both ports if a double-limb circuit is used — is recommended. Refer to the "Cleaning" chapter in the Clinician's manual.**
- **When handling any part of the ventilator, always follow appropriate infection control guidelines for handling infectious material.**
- **Covidien recognizes that cleaning, sterilization, sanitation, and disinfection practices vary widely among healthcare institutions. It is not possible for Covidien to specify or require specific practices that will meet all needs, or to be responsible for the effectiveness of cleaning, sterilization, and other practices carried out in the patient care setting.**
- **Covidien recommends that users of its products that require cleaning and sterilization/ disinfection consider the *National Standards and Recommended Practices for Sterilization* published by the Association for the Advancement of Medical Instrumentation (AAMI), as well as the following Center for Disease Control (CDC) publications: *Guidelines for Maintenance of In-use Respiratory Therapy Equipment* and *Guidelines for Prevention of Nosocomial Pneumonia*.**

Warnings Before Using Equipment

- **For a thorough understanding of ventilator operations, be sure to thoroughly read this manual and the Clinician's manual before attempting to use the ventilator.**
- **The ventilator must be used only under the responsibility and on the prescription of a doctor.**
- **Check the ventilator periodically as outlined in this manual; do not use if defective. Immediately replace parts that are broken, missing, obviously worn, distorted, or contaminated.**
- **Before activating any part of the ventilator, be sure to check the equipment for proper operation.**
- **To prevent patient injury, do not use a ventilator if it requires repair.**
- **If the ventilator is damaged or its external housing is not correctly closed or it behaves in a way that is not described in this manual (excessive noise, heat emission, unusual odor, alarms not triggered during the start-up procedure), the oxygen and power supplies should be disconnected and use of the device stopped immediately.**
- **Verify the functionality of the alarms before making ventilator available for patient use.**
- **Do not perform ventilator alarm tests while the patient is connected to the ventilator.**
- **If the ventilator fails any alarm tests, refer to Chapter 5 to service appropriate components. Refer to Table 4-3 to troubleshoot specific alarm messages.**
- **Do not start ventilation until you ensure the device is correctly assembled, the inlet air filter is properly installed and unobstructed, and there is proper clearance all around the unit. Also ensure the patient circuit is correctly connected to both the ventilator and the patient, and the patient circuit, including all hoses, is not damaged or obstructed.**

- **To minimize the risk of damage, you must use the ventilator's factory approved packaging to transport the ventilator.**
- **Do not use the ventilator without a properly installed inlet air filter or with a dirty inlet air filter.**
- **The inlet air filter is not reusable. Do not attempt to wash, clean, or reuse it.**
- **If you cannot determine the cause of a problem with the ventilator, contact Covidien Technical Support or your local representative. Do not use the ventilator on a patient until the problem has been corrected.**
- **To avoid injury and/or possible damage to the ventilator: before using the ventilator, use a flow meter (flow regulator) to regulate the oxygen supply to specifications before connecting the ventilator to the oxygen supply.**

General Warnings Regarding Use of Equipment

- **The ventilator must be used only under the responsibility and on the prescription of a doctor.**
- **The Puritan Bennett 560 Ventilator is not intended to be a comprehensive monitoring device and does not activate alarms for all types of dangerous conditions for patients on life-support equipment.**
- **Patients on life-support equipment should be appropriately monitored by competent medical personnel and suitable monitoring devices.**
- **An alternative source of ventilation should always be available when using the Puritan Bennett 560 Ventilator.**
- **Handle the ventilator with care during and after use, particularly when ambient temperatures are high. Some ventilator surfaces may become hot, even if safety specifications are not exceeded.**
- **Do not use sharp objects to make selections on the keyboard.**
- **Do not clean any gas pathway with a liquid cleaner. Refer to Table 2-14 for allowable cleaning and disinfecting agents for use on other parts of the ventilator.**
- **Use all cleaning solutions and products with caution. Read and follow the instructions associated with the cleaning solutions you use to clean your ventilator. Use only those solutions listed in Table 2-14.**
- **Never use a liquid cleaner inside the patient circuit, or on any component of a gas pathway.**
- **The SET UP menu is only accessible if ventilation is stopped and the ventilator is powered on while the ALARM CONTROL key is pressed.**

- **Even though the Puritan Bennett 560 Ventilator meets current safety standards, the internal lithium-ion battery of the device exceeds the 100Wh threshold and is therefore considered to be Dangerous Goods (DG) Class 9 – Miscellaneous, when transported in commerce. As such, the Puritan Bennett 560 Ventilator and/or the associated lithium-ion battery are subject to strict transport conditions under the Dangerous Goods Regulation for air transport (IATA: International Air Transport Association), International Maritime Dangerous Goods code for sea and the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) for Europe. Private individuals who transport the device are excluded from these regulations although for air transport some requirements apply. For air transport; the Puritan Bennett 560 Ventilator is permitted as checked-in or carry-on baggage. Two spare batteries per person may be taken on board as carry-on luggage only, with the prior approval of the airline. This classification and regulatory requirements may vary depending upon the country and mode of transport. Therefore it is recommended that users verify with the carrier / airline as to which measures to take before the voyage.**
- **A continuous alarm condition will be activated if the ventilator power is switched off during ventilation. When the power is switched back on, ventilation will resume without having to press the ventilator’s ON/OFF key.**
- **To ensure correct and lasting operation of the device, ensure the ventilator is installed and operated in the environmental conditions recommended in Appendix B, “Specifications” of the Clinician’s manual.**
- **To ensure correct and lasting operation of the ventilator, ensure its air circulation holes (main inlet or cooling) are never obstructed. Place the device in an area where air can freely circulate around the ventilator and avoid installing it near floating fabrics, such as curtains.**
- **The ventilator should never be immersed in any liquid, and any liquid on the surface of the device should be wiped away immediately.**
- **If the ventilator has been transported or stored at a temperature that differs more than ±20 °C (± 68 °F) from the temperature in which it will be operating, the ventilator should be allowed to stabilize in its operating environment for at least two (2) hours prior to use.**
- **If the ambient temperature is above 104 °F (40 °C), the battery's thermal cut-off circuit may prevent the battery from recharging fully-even if the INTERNAL BAT charging indicator indicates the battery is completely recharged.**
- **The default setting for altitude compensation is YES. Altitude compensation should always be set to YES for accurate volume delivery calculations at all elevations.**
- **If the ventilator is damaged or its external housing is not correctly closed or it behaves in a way that is not described in this manual (excessive noise, heat emission, unusual odor, alarms not triggered during the start-up procedure), the oxygen and power supplies should be disconnected and use of the device stopped immediately.**
- **The Puritan Bennett 560 Ventilator offers a variety of breath delivery modes. Throughout the patient’s treatment, the clinician should carefully select the ventilation mode or modes to use for that patient, based on clinical judgment, considering the condition and needs of the individual patient, as they change from time to time, and considering the benefits, limitations and operating characteristics of each mode.**

Warnings Regarding the Environment

- **For environmental protection, the ventilator and its components, whatever their respective conditions of operation, cannot be disposed of with household waste and must be submitted for suitable selective collection and possible recycling. Observe all applicable regulations when disposing of the ventilator and any of its components.**
- **Follow local governing ordinances and recycling regulations regarding disposal or recycling of batteries and other device components.**

Warnings Regarding Hoses and Accessories

- **The ventilator must not use, nor be connected to, any anti-static or electrically conductive hoses, tubing, or conduits.**
- **Resistance of the exhalation valve and accessories (water traps, filters, etc.) must be as low as possible.**
- **The exhalation valve must allow rapid discharge of the circuit pressure. Ensure the exhalation valve is always clean and its evacuation aperture (exhaust port) is never obstructed.**
- **Never use a ventilator or any components or accessories that appear to be damaged. If any signs of damage are evident, contact your equipment supplier or Covidien.**
- **After assembling, cleaning, or reassembling the patient circuit, inspect the hoses and other components to ensure there are no cracks or leaks and that all connections are secure.**
- **The hose connecting the ventilator to the oxygen source must be designed exclusively for use with medical-grade oxygen. Under no circumstances should the oxygen hose be modified by the user. In addition, the hose must be installed without the use of lubricants.**
- **The exhalation block is intended for single use by a single patient. It may periodically be cleaned, but it cannot be disinfected or sterilized.**
- **Ensure the exhalation block is completely dried after cleaning and prior to use.**
- **When an exhalation block is set up, each time it is removed, or after installing a new exhalation block on the machine, it is essential that the exhalation flow sensor be recalibrated before the exhalation block is used. Refer to Section 6.7.3.**

Warnings Regarding Electrical Power

- **The maximum recommended shelf life of the internal battery is two (2) years. Do not use a battery that has been stored for two years prior to its first use.**
- **Periodic recharging is important to help maximize useful life of the battery. Do not store the internal battery for extended periods, without recharging, as this may reduce the maximum life.**
- **Due to typical voltage fluctuations that occur during normal power wheelchair use, the wheelchair mains battery should never be used to power the Puritan Bennett 560 Ventilator, nor should the ventilator’s battery be used to power the wheelchair. The ventilator should always be connected to an independent power source (e.g. AC power, extra batteries, or DC power source).**

- **For the AC (“mains”) power cable to be properly secured, the attachment located on the power cable must be fitted into the power cable holder incorporated in the battery access cover and located under the AC (mains) power socket.**
- **The power supply to which the ventilator is connected (both AC and DC) must comply with all applicable standards and provide electrical power corresponding to the voltage characteristics inscribed on the rear of the ventilator and in Table 2-3 to ensure correct operation.**
- **After replacing the ventilator's internal battery, push on the battery's cover from the rear towards the front to take pressure off the cover mounting brackets, thereby avoiding breakage when the screws are tightened.**
- **Do not leave power cables lying on the ground where they may pose a hazard.**
- **Before cleaning the ventilator, first disconnect the ventilator and the patient circuit.**
- **Ensure that the AC power cable is in perfect condition and not compressed. The device should not be turned on if the AC power cable is damaged.**
- **To connect the ventilator to an external power source, first ensure the ventilator’s power switch is off. Then, connect the desired power cable to the ventilator. Finally, connect the power cable to the external power source.**
- **To disconnect the ventilator from an external power source, first power-down the ventilator. Then, disconnect the power cable from the external power source and, finally, the ventilator.**

Warnings Regarding Oxygen

- **Strictly follow the instructions provided in the Clinician’s manual for connecting the oxygen supply, which include the use of a flow regulator and special coupler.**
- **The oxygen supply must be regulated using a flow meter connected to the source gas outlet.**
- **The oxygen supply must be shut off when ventilation is off. Before disconnecting the oxygen hose, allow the ventilator to continue for a few cycles without oxygen to flush the patient circuit of excess oxygen.**
- **Before connecting the oxygen supply, ensure the stud on the oxygen connector is protruding outward.**
- **Inspect the oxygen connector before use to ensure its o-ring is attached and in good condition. Do not use an oxygen connector with a missing, worn, or damaged o-ring.**
- **In the event of an oxygen leak, shut down the supply of oxygen at its source. In addition, remove and/or keep any incandescent source away from the device, which may be enriched with oxygen. Circulate fresh air into the affected room to bring the oxygen level down to normal.**
- **To ensure stability, when the Puritan Bennett 560 Ventilator is mounted on a cart, the weight of the oxygen bottle should not exceed 14 kg (30 lb).**
- **Ensure the oxygen supply pressure to the machine never exceeds 7 psi (50 kPa) or a flow of 15 lpm.**

- **The hose connecting the ventilator to the oxygen source must be designed exclusively for use with medical-grade oxygen. Under no circumstances should the oxygen hose be modified by the user. In addition, the hose must be installed without the use of lubricants.**
- **Ensure the only gas supplied to the ventilator through the dedicated oxygen supply connector is medical-grade oxygen.**

Warnings Regarding USB Memory Device

- **Always verify that the serial number of the ventilator is correctly associated with the correct patient before using a USB memory device to transfer data between the ventilator and a PC.**

2 General Information

This manual provides information needed to service the Puritan Bennett™ 560 Ventilator. It is intended for use by biomedical engineering technicians or personnel with equivalent experience who have successfully completed Covidien training on this product.

This chapter provides introductory information on the Puritan Bennett 560 Ventilator including:

- a description of the ventilator, its accessories, and its controls and indicators
- a preventive maintenance schedule
- detailed specifications and required and test equipment used for service and repair
- an outline of the service philosophy.

2.1 About this Manual

COVIDIEN recommends that you become familiar with this manual and the *Puritan Bennett 560* Ventilator *Clinician's Manual (*for patient circuit setup, operation, and breath delivery information) before attempting to operate or maintain the ventilator.

This manual is intended to be a comprehensive guide for servicing the Puritan Bennett 560 Ventilator.

Chapter 1 provides safety information

Chapter 2 provides general information as described above.

Chapter 3 describes the ventilator's technical operating theory.

Chapter 4 contains alarm, diagnostic, and troubleshooting information, and suggests which components to replace based upon troubleshooting results.

Chapter 5 describes service prerequisites and provides step-by-step instructions for disassembling the ventilator, replacing components or assemblies, and reassembling the ventilator.

Chapter 6 defines required performance verification tests.

Chapter 7 contains parts lists and detailed assembly drawings for ordering replacement parts.

2.2 Product Description and Intended Use

The Puritan Bennett 560 Ventilator is indicated for the mechanical ventilatory support of patients weighing at least 5 kg (11 lb). It is not intended for ventilator-dependent patients. The servicing of the ventilator is intended to be performed by qualified, trained personnel. The ventilator is applicable for adult and pediatric patients who require the following general types of ventilatory support, as prescribed by an attending physician:

- Positive Pressure ventilation
- Assist/Control or CPAP modes of ventilation
- Pressure Control, and Pressure Support (ST) breath types.

The ventilator is suitable for use in institutional, home, and portable settings. It is not intended for use as an emergency transport ventilator.

The Puritan Bennett 560 Ventilator is a microprocessor-controlled ventilator consisting of a low-inertia micro turbine (blower) used for flow generation. A three-way solenoid valve is used to pilot an exhalation valve at the outlet of exhalation block. Flow and pressure sensors provide information to a CPU which uses control algorithms to provide closed-loop feedback control for breath delivery. An internal fan provides controlled cooling for electronic and pneumatic ventilator components.

The ventilator can be powered via external AC power, an external DC power source, or an internal battery during situations where there is a loss or absence of external power. A Power Management PCBA determines which power source (AC mains, external DC power source, or internal battery) is the primary supply depending on the availability of each source.

The servicing of the ventilator is intended to be performed by qualified, trained personnel and its use is applicable for adult and pediatric patients.

Table 2-1 provides a list of accessories that are available for the Puritan Bennett 560 Ventilator.

To order parts or accessories, contact your equipment supplier or COVIDIEN representative.

WARNING
Use only accessories recommended by Covidien.

Note:
The Puritan Bennett 560 Ventilator is shipped with the following items: clinician's manual on CD-ROM (multi-language), one set of six (6) inlet air filters, carrying bag, one O_2 inlet connector, European power cable, and an adult, double limb breathing circuit. Table 2-2 lists available breathing circuits and other consumable items.

Table 2-1. Ventilator Accessories

Description	Part number
Carrying bag	3829000
Oxygen inlet connector (x10)	2962799
Carrying belt	3819100

Table 2-1. Ventilator Accessories (continued)

Description	Part number
Suspension belt	3819200
Backpack, padded suspenders	3819300
Dual Bag, Pink	2967200P
Dual Bag, includes: • Backpack padded suspenders, 2 ea. (3819300) • Suspension belt (3819200) • Carrying belt (3819100)	2967299
DC power source (external battery, Puritan Bennett™ 560 Ventilator Power Pack), includes interconnect cable	4098100
24 V DC cable for DC power source (300 mm)	3841000
AC (mains) power cable assembly, Australia	2981499
AC (mains) power cable assembly, Canada	2977099
AC (mains) power cable assembly, UK	2971899
AC (mains) power cable assembly, Japan	2972099
AC (mains) power cable assembly, China	2972399
AC (mains) power cable assembly, SAF/India	2972499
AC (mains) power cable assembly, EU	2971799
AC (mains) power cable assembly, Latin America	various, contact your local representative
12 V cable (for connection to automobile DC power port)	10094625
RAII, with 1/4 inch jack connector: -Remote alarm cable, NO (normally open) -Remote alarm cable, NC (normally closed)	 10003919 10094353
Remote alarm cable without jack connector: -Remote alarm cable, RA -Remote alarm cable, RAII	 10094626 10000914
RS232 serial cable	4-074688-00 or local supplier
USB cable, mini B	10094627 or equivalent
USB 2.0 serial converter	Local supplier
Utility Cart	4096800

Table 2-2. Consumable Parts

Description	Part number
Exhalation block, single-patient use (blue)	10046892
Inlet air combi filter, fine (pack of 6)	10028771
Inspiratory bacteria filter: Barrierbac S Barrierbac S Angled Hygrobac Hygrobac S Hygrobac S Angled Hygroboy Hygroster Hygroster Mini Sterivent Sterivent S Sterivent Mini*	 350U5879 350U19006 352U5805 352U5877 352U5996 355U5430 354U5876 354U19028 351U5410 351U5878 351U5979
Double-limb patient circuit with exhalation valve, 180 cm, PVC, non-sterile, ADULT	5094000
Double-limb patient circuit with exhalation valve, 180 cm, PVC, non-sterile, PEDIATRIC	5093900
Single-limb patient circuit with exhalation valve, 180 cm, PVC, non-sterile, ADULT	5093600
Single-limb patient circuit with exhalation valve, 180 cm, PVC, non-sterile, PEDIATRIC	5093500
Single-limb patient circuit without exhalation valve, 180 cm, PVC, non-sterile, ADULT	5093300
Single-limb patient circuit without exhalation valve, 180 cm, PVC, non-sterile, PEDIATRIC	5093100

*Do not use Sterivent Mini filters to test or calibrate the ventilator

2.3 Specifications

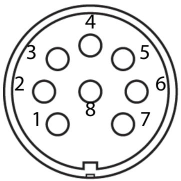
Table 2-3. Ventilator Specifications

Physical characteristics	
Weight	9.9 lb (4.5 kg)
Dimensions (excluding accessories)	9.3 in wide x 12.4 in deep x 6.0 in high (235 mm wide x 315 mm deep x 154 mm high)
Connectors	Inspiratory limb connector: ISO 22 mm (OD) 15 mm (ID) conical Exhalation limb connector (on exhalation block): ISO 22 mm (ID) conical Oxygen inlet: female connector with valve Exhalation pilot port: accommodates 3.2 mm to 4 mm ID tubing Proximal pressure port: accommodates 5 mm to 6 mm ID tubing
Environmental requirements	
Temperature	Operating: 5° to 40° C (41° to 104° F) 20 minutes after conditioning at 23° C Storage: -40° to 70° C (-40° to 158° F)
Atmospheric pressure	Operating: 450 to 825 mmHg (600 to 1100 hPa; 8.7 to 15.9 psi) Storage: 375 to 825 mmHg (500 to 1100 hPa; 7.3 to 15.9 psi)
Altitude	Operating/storage: -500 ft to 13,000 ft (-152 m to 3962 m)
Humidity	Operating/storage: 10% to 95% RH noncondensing
Combination temperature and humidity	Operating: 113° F (45° C) and 75% RH
DC voltage supply	-10% to +10% of nominal (12-30 V DC)
Pneumatic specifications	
Turbine	Maximum flow: 240 lpm at 24 cmH_2O ± 1% Maximum pressure: ≥ 70 cmH_2O at 0 lpm
Oxygen inlet	Pressure: 7 psi max (50 kPa) Flow: 15 lpm max
Electrical specifications	
AC input	100 V AC – 240 V AC nominal (84 V AC – 264 V AC) 50 Hz – 60 Hz nominal (47 Hz – 63 Hz) 180 VA max 430 BTUs per hour
DC supply	12 V DC ± 10%, 8.3 A to 30 V DC ± 10%, 3.3 A max

Table 2-3. Ventilator Specifications (continued)

Internal battery (Puritan Bennett 560 Ventilator)	lithium ion 26 V DC (nominal), 4.8 Ah full load capacity Charging current: Standby ventilation: 1.5 A/h (duration: < 6 h) During ventilation: 0.5 A/h (duration: <13 h) Average operating time (- 10%) at 25 ºC (± 5 ºC) with a fully charged battery with less than 50 charge/discharge cycles at the following ventilator settings: 11 h when Vt = 200 mL (± 5 mL), Pi = 10 cmH_2O (± 2 cmH_2O), Rtot = 20 bpm 9 h when Vt = 300 mL (± 5 mL), Pi = 20 cmH_2O (± 2 cmH_2O), Rtot = 15 bpm 6.5 h when Vt = 500 mL (± 5 mL), Pi = 30 cmH_2O (± 2 cmH_2O), Rtot = 15 bpm 4.5 h when Vt = 750 mL (± 5 mL), Pi = 45 cmH_2O (± 2 cmH_2O), Rtot = 20 bpm Shelf life: Installed in ventilator (without recharging): 6 months Not installed in ventilator (spare battery): 24 months **WARNING** **Even though the Puritan Bennett 560 Ventilator meets current safety standards, the internal lithium-ion battery of the device exceeds the 100Wh threshold and is therefore considered to be Dangerous Goods (DG) Class 9 – Miscellaneous, when transported in commerce. As such, the Puritan Bennett™ 560 Ventilator and/or the associated lithium-ion battery are subject to strict transport conditions under the Dangerous Goods Regulation for air transport (IATA: International Air Transport Association), International Maritime Dangerous Goods code for sea and the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) for Europe. Private individuals who transport the device are excluded from these regulations although for air transport some requirements apply. For air transport; the Puritan Bennett™ 560 Ventilator is permitted as checked-in or carry-on baggage. Two spare batteries per person may be taken on board as carry-on luggage only, with the prior approval of the airline. This classification and regulatory requirements may vary depending upon the country and mode of transport. Therefore it is recommended that users verify with the carrier / airline as to which measures to take before the voyage.**

Table 2-3. Ventilator Specifications (continued)

<table>
<tr>
<td>Communication capabilities</td>
<td>
<p>Remote alarm (nurse call) port. Allows alarm conditions to be annunciated at locations away from the ventilator (for example, when the ventilator is in an isolation room). The ventilator signals an alarm using a normally open or a normally closed signal.</p>
<p>The ventilator asserts a remote alarm when there is an active alarm condition, unless the audio paused function is active, and when the ventilator power switch is turned off. The remote alarm port is an8-pin female connector. Allowable current is 100 mA at 24 V DC (maximum).</p>


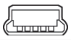
<p>Nurse call pin-out (view from back of ventilator)</p>
<table>
<tr><th>Pin</th><th>Signal</th><th>Remote alarm cable wire color</th></tr>
<tr><td>1</td><td>relay common</td><td>black</td></tr>
<tr><td>2</td><td>normally open (NO)</td><td>brown</td></tr>
<tr><td>3</td><td>normally closed (NC)</td><td>orange</td></tr>
<tr><td>4</td><td>not used</td><td>--</td></tr>
<tr><td>5</td><td>not used</td><td>--</td></tr>
<tr><td>6</td><td>not used</td><td>--</td></tr>
<tr><td>7</td><td>not used</td><td>--</td></tr>
<tr><td>8</td><td>not used</td><td>--</td></tr>
</table>
<p>WARNING</p>
<p>To connect the ventilator to a Nurse Call device, contact Covidien to check the ventilator’s compatibility with the Nurse Call device and order a suitable connection cable. Before using the Nurse Call system, ensure that its connections are secure and it operates properly. Do not use Nurse Call devices that operate based on the closure of an electrical circuit, because the devices often do not take into account possible cable disconnection or a total loss of power. Ensure that the Nurse Call device is always connected to the ventilator.</p>
</td>
</tr>
<tr>
<td></td>
<td>
<p>PC communication port. Allows communication between the ventilator and a PC. Used for software uploads and data downloads.</p>

</td>
</tr>
</table>

Table 2-3. Ventilator Specifications (continued)

	USB Type A ports. Two Type A USB ports are included on the Puritan Bennett 560 Ventilator for obtaining trended, event, and monitoring information.
Alarm volume	65 to 80 dBA ± 10% (as measured per IEC 60601-1-8)
Ventilator operating volume	≤ 30 dBA + 10%
Ventilator airway resistance	
Inspiratory resistance	1.0 cmH$_2$O at 30 lpm 3.7 cmH$_2$O at 60 lpm
Exhalation resistance	0.5 cmH$_2$O at 30 lpm 1.1 cmH$_2$O at 60 lpm
Ventilator airway compliance	
Internal ventilator compliance	0.0001 L/cmH$_2$O
Performance specifications	
Working pressure	5 cmH$_2$O - 55 cmH$_2$O
Maximum pressure limit	60 cmH$_2$O
Sound pressure level	30 dBA per ISO 17510-1 test conditions
Patient circuit inspiratory resistance	
Adult double branch circuit with exhalation valve	≤ 2 cmH$_2$O at 60 lpm
Pediatric double branch circuit with exhalation valve	≤ 2 cmH$_2$O at 30 lpm
Inlet air filter specifications	
Filter type	mechanical; foam and fine particle filter
Filtration efficiency	99.999982% at 30 lpm (filtering microbes 3.3 µm)
Flow resistance	0.06 cmH$_2$O at 24 lpm
Inspiratory bacteria filter specifications	
Maximum allowable flow resistance (pressure drop)	4 cmH$_2$O at 60 lpm

2.4 Range, Resolution, and Accuracy

Ranges, resolutions, and accuracies, for ventilator settings, alarm settings, and patient data are listed in Table 2-4.

Note:

Accuracies only apply in monitored patient data values.

Table 2-4. Range, Resolution, and Accuracy

Setting or monitored parameter	**Range, resolution, and accuracy**
Ventilator settings	
Apnea Time (available in PSV ST, CPAP, P SIMV, and V SIMV)	Range: AUTO or 1 - 60 s Resolution: 1 s Default value: AUTO Dependencies: Backup R, R-Rate In PSV ST, Apnea time: AUTO = 60/Backup R s In V SIMV or P SIMV, Apnea Time: AUTO = 12 s
WARNING **•In SIMV modes, no apnea alarm occurs if set Apnea Time > 60/R-Rate.** **•In CPAP mode, APNEA TIME only drives the alarm signal — there is no backup rate.** **If the user has set Apnea Time to OFF in the SETUP menu, then the patient will receive backup ventilation during an APNEA condition, but will not sound an alarm.**	
Backup Rate (Backup R) (available in PSV ST)	Range: 4 - 40 bpm or OFF Resolution: 1 bpm Default value: 13 Dependencies: Low I time In P SIMV and V SIMV, Backup rate = Max (8, R-Rate) and is not adjustable
Expiratory Sensitivity (Esens) (available in PSV ST, V SIMV, P SIMV)	Range: 5% to 95% of peak flow or -95% to -5% of peak flow depending upon E Sens setting selected in SETUP mode; positive or negative) Resolution: 5% Default value: 75% (AUTO) In CPAP Exh Sens is fixed at 25% and is not adjustable.
Flow pattern (available in V A/C)	Range: Square, descending ramp, or sinusoidal Resolution: N/A Default value: Descending ramp In V SIMV, flow pattern is set to square and is not adjustable
Inspiratory Sensitivity (Insp Sens) (available in V A/C, P A/C, PSV ST, P SIMV, and V SIMV)	Range: OFF or 0P - 5 (0P indicates a pediatric setting. Autotriggering may result if this setting is used while ventilating an adult patient.) Resolution: 1 Default value: 2 In CPAP, Insp Sens is fixed at 2 and is not adjustable

Table 2-4. Range, Resolution, and Accuracy (continued)

Setting or monitored parameter	Range, resolution, and accuracy
Inspiratory Time (Insp Time) (available in P A/C, V A/C, P SIMV, V SIMV)	Range: 0.3 s to 6.0 s in P A/C and V A/C modes; 0.3 s to 2.4 s in P SIMV and V SIMV modes Resolution: 0.1 s Default value: 1.5 s Dependencies: R-Rate in P SIMV mode; R-Rate and Vt in V SIMV mode
Mode	Range: V A/C, P A/C, V SIMV, P SIMV, PS V ST, CPAP Resolution: N/A Default value: P A/C
PEEP	Range: OFF or 1 to 20 cmH_2O; OFF corresponds to a 0.5 cmH_2O target Resolution: 1 cmH_2O Default value: OFF Dependencies: Pi, P Support, Low PIP, High PIP **Note:** The minimum PEEP value in CPAP mode is 4 (pressure units chosen by user) and OFF is not available. In non-invasive ventilation the minimum value of PEEP is 4 (pressure units chosen by user).
Inspiratory Pressure (Pi)	Range: 5 cmH_2O to 55 cmH_20 in P A/C in valve configuration or 6 cmH_2O to 30 cmH_20 in leak configuration (See Section 3.6.5 for the differences between valve and leak configurations) Resolution: 1 cmH_2O Default value: 15 cmH_2O Dependencies: PEEP
Pressure Support (P Support) (available in P SIMV, V SIMV, PSV ST)	Range: OFF or 5 cmH_2O to 55 cmH_20 in valve configuration or 5 cmH_2O to 30 cmH_20 in leak configuration (See Section 3.6.5 for the differences between valve and leak configurations) Resolution: 1 cmH_2O Default value: 15 cmH_2O Dependencies: PEEP, Low PIP, High PIP
Respiratory Rate (R-Rate) (available in V A/C, P A/C, V SIMV, P SIMV)	Range: 1 bpm - 60 bpm in V A/C and P A/C modes;1 bpm - 40 bpm in P SIMV and V SIMV modes with I:E not exceeding 1:2Resolution: 1 bpm Default value: 13 Dependencies: Insp Time in P SIMV mode; Insp Time and Vt in V SIMV mode

Table 2-4. Range, Resolution, and Accuracy (continued)

Setting or monitored parameter	**Range, resolution, and accuracy**
Rise Time (available in P A/C, PSV ST, P SIMV, V SIMV)	Range: 1-4 (1 is fastest, 4 is slowest) Resolution: 1 Default value: 2 Dependencies: Insp time
Tidal Volume Vt (available in V SIMV, V A/C)	Range: 50 mL to 2000 mL Resolution: 10 mL Default value: 500 mL Dependencies: Insp time, R-Rate, Low VTI, High VTI, Low VTE, High VTE, Low Min Vol, High Min Vol
I:E ratio (available in P A/C and V A/C)	Range: 9.9:1 to 1:9.9 Resolution: 0.1 Default value: 1:2
I/T ratio (available in P A/C and V A/C)	Range: 20% to 50% Default value: 33% Resolution:1%
Vt target (available in P A/C,PSV ST)	Range: 50 mL to 2000 mL; OFF Resolution: 10 mL Default value: OFF (100 mL)
High Inspiratory Time (High I time)	Range: 0.8 to 3.0 s Resolution: 0.1 s Default value: AUTO (minimum of 3 s or 30/monitored rate) Dependencies: Low I time, R-Rate
Low Inspiratory Time (Low I time)	Range: AUTO or 0.1 to2.8 s Resolution: 0.1 s Default value: AUTO (Rise time + 300 ms) Dependencies: High I time, Backup R, Rise time
Alarm settings (based on breath mode)	
Pressure A/C mode	
High Inspired Tidal Volume (High VTI)	Range: 80 mL to 3000 mL; OFF Resolution: 10 mL Default value: 2000 mL Dependencies: Low VTI
High Exhaled Tidal Volume (High VTE)	Range: 80 mL to 3000 mL; OFF Resolution: 10 mL Default value:1000 mL Dependencies: Vt, Low VTE

Table 2-4. Range, Resolution, and Accuracy (continued)

Setting or monitored parameter	Range, resolution, and accuracy
High Respiratory Rate (High Rtot)	Range: 10 bpm to 70 bpm; OFF Resolution: 1 bpm Default value: OFF Dependencies: R-Rate
Low Exhaled Tidal Volume (Low VTE)	Range: 30 mL to 1990 mL; OFF Resolution: 10 mL Default value: 300 Dependencies: Vt, High VTE
Low Inspired Tidal Volume (Low VTI)	Range: 30 mL to 2000 mL; OFF Resolution: 10 mL Default value: 300 mL Dependencies: High VTI
High leak	Range: 5 lpm - 200 lpm; OFF Resolution: 5 lpm Default value: OFF To be used in non-invasive ventilation without an exhalation valve
PSV ST mode	
High Exhaled Tidal Volume (High VTE)	Range: 80 mL to 3000 mL; OFF Resolution: 10 mL Default value:1000 mL Dependencies: Vt, Low VTE
High Inspired Tidal Volume (High VTI)	Range: 80 mL to 3000 mL; OFF Resolution: 10 mL Default value: 2000 mL Dependencies: Low VTI
High Respiratory Rate (High Rtot)	Range: 10 bpm to 70 bpm; OFF Resolution: 1 bpm Default value: OFF Dependencies: Backup R
Low Exhaled Tidal Volume (Low VTE)	Range: 30 mL to 1990 mL; OFF Resolution: 10 mL Default value: 300 Dependencies: Vt, High VTE
Low Inspired Tidal Volume (Low VTI)	Range: 30 mL to 2000 mL; OFF Resolution: 10 mL Default value: 300 mL Dependencies: High VTI

Table 2-4. Range, Resolution, and Accuracy (continued)

Setting or monitored parameter	**Range, resolution, and accuracy**
High leak	5 - 200 lpm or OFF To be used in non-invasive ventilation without an exhalation valve
	V SIMV mode
High Exhaled Tidal Volume (High VTE)	Range: 80 mL to 3000 mL; OFF Resolution: 10 mL Default value:1000 mL Dependencies: Vt, Low VTE
High PIP	Range: 12 cmH_2O to 60 cmH_2O Resolution: 1 cmH_2O Default value: 40 cmH_2O Dependencies: PEEP, P support, Low PIP
High Respiratory Rate (High Rtot)	Range: 17 bpm to 70 bpm; OFF Resolution: 1 bpm Default value: OFF Dependencies: R-Rate
Low PIP	Range: 2 cmH_2O to 52 cmH_2O Resolution: 1 cmH_2O Default value: 2 cmH_2O Dependencies: PEEP, P support, High PIP The Low PIP value will automatically be raised to set PEEP + 2 if PEEP is increased to a level that surpasses Low PIP - 2
Low Exhaled Tidal Volume (Low VTE)	Range: 30 mL to 1990 mL; OFF Resolution: 10 mL Default value: 300 Dependencies: Vt, High VTE
	P SIMV mode
High Exhaled Tidal Volume (High VTE)	Range: 80 mL to 3000 mL; OFF Resolution: 10 mL Default value: 1000 Dependencies: Low VTE
High Inspired Tidal Volume (High VTI)	Range: 80 mL to 3000 mL; OFF Resolution: 10 mL Default value: 2000 mL Dependencies: Low VTI

Table 2-4. Range, Resolution, and Accuracy (continued)

Setting or monitored parameter	**Range, resolution, and accuracy**
High Respiratory Rate (High Rtot)	Range: 17 bpm to 70 bpm; OFF Resolution: 1 bpm Default value: OFF Dependencies: R-Rate
Low Exhaled Tidal Volume (Low VTE)	Range: 30 mL to 1990 mL; OFF Resolution: 10 mL Default value: 300 Dependencies: High VTE
Low Inspired Tidal Volume (Low VTI)	Range: 30 mL to 2000 mL; OFF Resolution: 10 mL Default value: 300 Dependencies: High VTI
Volume A/C mode	
High Exhaled Tidal Volume (High VTE)	Range: 80 mL to 3000 mL; OFF Resolution: 10 mL Default value:1000 Dependencies: Vt, Low VTE
High Peak Inspiratory Pressure (High PIP)	Range: 12 cmH_2O to 60 cmH_2O Resolution: 1 cmH_2O Default value: 40 cmH_2O Dependencies: PEEP, Low PIP The High PIP value will automatically be raised to set PEEP + 10 if PEEP is increased to a level that surpasses High PIP - 10
High Respiratory Rate (High Rtot)	Range: 10 bpm to 70 bpm; OFF Resolution: 1 bpm Default value: OFF Dependencies: R-Rate
Low Exhaled Tidal Volume (Low VTE)	Range: 30 mL to 1990 mL; OFF Resolution: 10 mL Default value: 300 Dependencies: Vt, High VTE
Low Peak Inspiratory Pressure (Low PIP)	Range: 2 cmH_2O to 52 cmH_2O Resolution: 1 cmH_2O Default value: 2 cmH_2O Dependencies: PEEP, High PIP The Low PIP value will automatically be raised to set PEEP + 2 if PEEP is increased to a level that surpasses Low PIP - 2

Table 2-4. Range, Resolution, and Accuracy (continued)

Setting or monitored parameter	**Range, resolution, and accuracy**
CPAP	
High Inspired Tidal Volume (High VTI)	Range: 80 mL to 3000 mL; OFF Resolution: 10 mL Default value: 2000 mL Dependencies: Low VTI
High leak	Range: 5 to 200 lpm; OFF Resolution: 5 lpm Default value: OFF
High Respiratory Rate (High Rtot)	Range: 10 bpm to 70 bpm; OFF Resolution: 1 bpm Default value: OFF Dependencies: R-Rate
Low Inspired Tidal Volume (Low VTI)	Range: 30 mL to 2000 mL; OFF Resolution: 10 mL Default value: 300 Dependencies: High VTI
Monitored patient data	
Exhaled Tidal Volume (VTE)	Resolution: 5 mL Accuracy: ± (10 mL + 10%)
Expiratory Time (Etime)	Resolution: 0.1 s Accuracy: ± (100 ms)
I:E Ratio (I:E)	Resolution: 0.1 Accuracy: Insp. time ±50 ms and Exh. time ±50 ms or I:E ratio ±10%, whichever is greater
I/T Ratio	Resolution: 1% Accuracy: Insp. time ±50 ms and Exh. time ±50 ms or I/T ratio ±10%, whichever is greater
Minute Volume (M. Vol)	Resolution: 0.1 L Accuracy: ± (10 mL + 10% VTI) x rate in valve configuration and ± (20 mL + 20% VTI) x rate in leakage configuration)

Table 2-4. Range, Resolution, and Accuracy (continued)

Setting or monitored parameter	**Range, resolution, and accuracy**
Inspiratory Tidal Volume (VTI)	In valve configuration: Resolution: 5 mL Accuracy: ± (10 mL + 10%) and ± (20 mL +20%) in CPAP mode above 200 mL In leak configuration: Resolution: 5 mL Accuracy: ± (20 mL +20%)
Positive End Expiratory Pressure (PEEP)	Resolution: 1 cmH_2O Accuracy: ± (2 cmH_2O + 8% of reading)
Total Respiratory Rate (R tot)	Resolution: 1 bpm Accuracy: ± 1 bpm
Leak (displayed only in leak ventilation without exhalation valve)	Resolution: 1 lpm Accuracy:± (3 lpm + 20%)
% Spontaneous cycles (appears in the ventilation report menu)	Resolution: 1% Accuracy:± (1%)
Apnea index (AI)	Resolution: 1 Accuracy:± 1 ev/h

2.5 Default Settings

Table 2-5 through Table 2-7 lists the default settings of the Puritan Bennett 560 Ventilator. Downloading a new software version to the ventilator is the only way to automatically reset the ventilator's parameters to these settings. You should, however, manually enter these settings when you are finished servicing the ventilator if applicable.

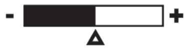
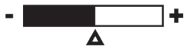
Table 2-5. Default Settings

Parameter	Setting
Mode	P A/C
Pi	15 cmH_2O
PEEP	OFF
Rise Time	2
R - Rate	10
I:E	1:3.6 or 1.3s or (I/T of 22%)
Insp Sens	2
Vt Target	OFF

Table 2-6. Default Alarm Settings

Alarm	Setting
VTI (ml)	Low 300 mL; High 2000 mL
VTE (ml)	Low 300 mL; High 1000 mL
Rtot (bpm)	Low -- High OFF

Table 2-7. Default Preferences (after software download)

Preference	Setting
Backlight	OFF
Contrast	
Alarm Volume	
Key Sound	Accept tone
Apnea Alarm	YES
Disconnection alarm	15s
Display Waveforms	OFF
Pediatric Circuit	OFF
Ventilation Report	N/A

Note: Access the Preferences menu from the main ventilation screen by placing the cursor on the Preferences position and pressing **ENTER**.

The ventilation report contains average values for a 24-hour period from 8:00 a. m. to 8:00 a.m. The report includes VTI, VTE, airway pressure, Rate, Leak, Apnea Index (apneic events per hour), Apnea Time, % Spontaneous cycles, machine hours, and patient hours.

2.6 Compliance and Approvals

The Puritan Bennett 560 Ventilator was developed in accordance with pertinent North American and International standards (Table 2-8). The manufacturing facility for this product is certified to EN ISO 13485:2000 (ISO 13485:1996) Quality Systems - Medical Devices - Particular Requirements for the Application of ISO 9001:1994.

The ventilator's IEC 60601-1/EN 60601-1 classification is protection class II internally and mains powered (with detachable power cord), Type BF applied parts, IPX1 (protection from ingress of moisture, continuous operation. The device is not suitable for use with flammable anesthetics, and is not suitable for sterilization.

Table 2-8. Ventilator Compliance with Standards

Standards/certifications
IEC 60601-1 Medical electrical equipment, Part 1: General requirements for safety: 1988 and all its amendments up to 1995 and EN 60601-1:1990
UL 60601-1 Medical electrical equipment, Part 1: General requirements for safety: 2003
IEC/EN 60601-1-2 Medical electrical equipment, Part 1-2: General requirements for safety, Collateral Standard: Electromagnetic compatibility - Requirements and tests: 2007
IEC 60601-1-4 Medical electrical equipment, Part 1: General requirements for safety-2- Collateral Standard: Programmable Electrical Medical Systems: 2000
EN 60601-1-4 Medical electrical equipment, Part 1: General requirements for safety-2- Collateral Standard: Programmable Electrical Medical Systems: 2004
IEC 60601-1-6 Medical electrical equipment, Part 1: General requirements for safety-2- Collateral Standard: Usability: 2006
EN 60601-1-6 Medical electrical equipment, Part 1: General requirements for safety-2- Collateral Standard: Usability: 2007
IEC 60601-1-8 General requirements, tests and guidance for alarm systems in medical electrical equipment and medical electrical systems: 2006
EN 60601-1-8 General requirements, tests and guidance for alarm systems in medical electrical equipment and medical electrical systems: 2007
EN ISO 10651-2 Lung ventilators for Medical Use - Particular Requirements for basic safety and Essential Performance, Part 2: Home Care Ventilators for Ventilator-Dependent Patients: 2009 and Chinese version YY0600.2-2007
CAN/CSA C22.2 No. 601-1-M90 Supplement 1-94 Medical Electrical Equipment, Part 1: General Requirements for Safety: Reaffirmed 2005
Medical Device Directive 93/42/EEC as amended by 2007/47/EC.
Directive 2006/66/EC: 2006 Batteries and Accumulators and Waste Batteries and Accumulators
Directive 2002/96/EC: 2003 Waste Electrical and Electronic Equipment

Table 2-8. Ventilator Compliance with Standards

Standards/certifications
EN ISO 5356-1 Anesthetic and respiratory equipment - Conical connectors - Part 1: Cones and sockets: Part 1 re-issued 2004
EN 50419 Marking of Electrical and Electronic Equipment: 2005
ISO 10651-3: 1997 Sections 21.6a (vibration sinusoidal) 21.6b (random vibration), and 21.6.c (bump test) of Lung Ventilator for Medical Use - Part 3: Particular Requirements for Emergency Transport Ventilators
Compatible with drop test according to 10.1.3 d article of draft IEC 60601-1-11: 2008 Medical Electrical Equipment - Part 1-11: General Requirements for Basic Safety and Essential Performance - Collateral Standard: Requirements for Medical Electrical Equipment and Medical Electrical Systems used in the Home Healthcare Environment (document IEC/SC62A 62A/624/CD)
RTCA DO-160E: 2007 section 21 (emission of Radio Frequency Energy) of Environmental Conditions and Test Procedures for Airborne Equipment
EN ISO 10651-6: 2009 Lung Ventilators for Medical Use - Particular Requirements for Basic Safety and Essential Performance Part 6: Home Care ventilatory support devices and Chinese version YY0600.1-2007

2.6.1 Manufacturer’s Declaration

The following tables contain the manufacturer’s declarations for the Puritan Bennett 560 Ventilator electromagnetic emissions, electromagnetic immunity, recommended separation distances between ventilator and portable and mobile RF communications equipment, and a list of compliant cables.

WARNING

- **Portable and mobile RF communications equipment can affect the performance of the Puritan Bennett 560 Ventilator. Install and use this device according to the information contained in this manual and the Puritan Bennett 560 Ventilator Operator’s and Clinician’s Manual.**
- **The Puritan Bennett 560 Ventilator should not be used adjacent to or stacked with other equipment, except as specified in this manual and the Puritan Bennett 560 Ventilator Operator’s and Clinician’s manual. If adjacent or stacked use is necessary, the ventilators should be observed to verify normal operation in the configurations in which they will be used.**

The Puritan Bennett 560 Ventilator is intended for use in the electromagnetic environment specified below. The customer or the user of the ventilator should assure that it is used in such an environment.

Table 2-9. Electromagnetic Emissions

Emissions test	Compliance level	Electromagnetic environment – guidance
Radiated RF emissions CISPR 11	Group 1 Class B	The Puritan Bennett 560 Ventilator uses RF energy only for its internal functions. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
Conducted RF emissions CISPR 11	Group 1 Class B	The Puritan Bennett 560 Ventilator is suitable for use in all establishments including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

Table 2-10. Electromagnetic Immunity

Immunity test	IEC 60601-1-2 test level	Compliance level	Electromagnetic environment – guidance
Electrostatic discharge (ESD) IEC 61000-4-2	± 6 kV contact ± 8 kV air	± 6 kV contact ± 8 kV air	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	± 2 kV for power supply lines ± 1 kV for input/output lines	± 2 kV for power supply lines ± 1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	± 1 kV lines/lines ± 2 kV lines/earth	± 1 kV lines/lines ± 2 kV lines/earth	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	< 5% U_T (> 95% dip in U_T for 0.5 cycle)	< 5% U_T (> 95% dip in U_T for 0.5 cycle)	Mains power quality should be that of a typical commercial or hospital environment. If the user of the Puritan Bennett 560 Ventilator requires continued operation during power mains interruptions, it is recommended that the Puritan Bennett 560 Ventilator be powered from an uninterruptible power supply or a battery.
	40% U_T (60% dip in U_T for 5 cycles)	40% U_T (60% dip in U_T for 5 cycles)	
	70% U_T (30% dip in U_T for 25 cycles)	70% U_T (30% dip in U_T for 25 cycles)	
	< 5% U_T (> 95% dip in U_T for 5 s)	< 5% U_T (> 95% dip in U_T for 5 s)	
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
Note: U_T is the AC mains voltage prior to application of the test level.			

Table 2-11. Electromagnetic Immunity — Conducted and radiated RF

Immunity test	IEC 60601-1-2 test level	Compliance level	Electromagnetic environment – guidance
			Portable and mobile RF communications equipment should be used no closer to any part of the Puritan Bennett 560 Ventilator, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz outside ISM bands[a]	3 Vrms 150 kHz to 80 MHz outside ISM bands	Recommended separation distance $d = 0.35\sqrt{P}$
	10 Vrms inside ISM bands[a]	10 Vrms inside ISM bands	$d = 1.2\sqrt{P}$
Radiated RF IEC 61000-4-3	10 V/m 80 MHz to 2.5 GHz	10 V/m 80 MHz to 2.5 GHz	$d = 1.2\sqrt{P}$ 80 MHz to 800 MHz
			$d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz
where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m)[b]. Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey[c], should be less than the compliance level in each frequency range[d]. Interference may occur in the vicinity of equipment marked with the following symbol:			

Table 2-11. Electromagnetic Immunity — Conducted and radiated RF (continued)

<table>
<tr><th>Immunity test</th><th>IEC 60601-1-2 test level</th><th>Compliance level</th><th>Electromagnetic environment – guidance</th></tr>
<tr><td colspan="4">Note:
• At 80 MHz and 800 MHz, the higher frequency range applies.
• These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.</td></tr>
<tr><td colspan="4">[a] The ISM (industrial, scientific, and medical) bands between 150 kHz and 80 MHz are 6.765 MHz to 6.795 MHz’; 13.553 MHz to 13.567 MHz; 26.957 MHz to 27.283 MHz; and 40.66 MHz to 40.70 MHz.
[b] The compliance levels in the ISM frequency bands between 150 kHz and 80 MHz and in the frequency range 80 MHz to 2.5 GHz are intended to decrease the likelihood that mobile/portable communications equipment could cause interference if it is inadvertently brought into patient areas. For this reason, an additional factor of 10/3 is used in calculating the recommended separation distance for transmitters in these frequency ranges.
[c] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the Puritan Bennett 560 Ventilator is used exceeds the applicable RF compliance level above, the Puritan Bennett 560 Ventilator should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the Puritan Bennett 560 Ventilator.
[d] Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 10 V/m.</td></tr>
</table>

Table 2-12. Recommended Separation Distances Between Portable and Mobile RF Communications Equipment and the Ventilator

Rated maximum output power of transmitter (W)	Separation distance according to frequency of transmitter (m)			
	150 kHz to 80 MHz outside ISM bands $d = 0.35\sqrt{P}$	150 kHz to 80 MHz in ISM bands $d = 1.2\sqrt{P}$	80 MHz to 800 MHz $d = 1.2\sqrt{P}$	800 MHz to 2.5 GHz $d = 2.3\sqrt{P}$
0.01	0.035	0.12	0.12	0.23
0.1	0.11	0.38	0.38	0.73
1	.35	1.2	1.2	2.3
10	1.1	3.8	3.8	7.3
100	3.5	12	12	23

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be determined using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

Note:

- At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.
- The ISM (industrial, scientific, and medical) bands between 150 kHz and 80 MHz are 6.765 MHz to 6.795 MHz; 13.553 MHz to 13.567 MHz; 26.957 MHz to 27.283 MHz; and 40.66 MHz to 40.70 MHz.

- An additional factor of 10/3 is used in calculating the recommended separation distance for transmitters in the ISM frequency bands between 150 kHz and 80 MHz and in the frequency range 80 MHz to 2.5 GHz to decrease the likelihood that mobile/portable communications equipment could cause interference if it is inadvertently brought into patient areas.

These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.

WARNING

The use of accessories and cables other than those specified with the exception of parts sold by Covidien as replacements for internal components, may result in increased emissions or decreased immunity of the Puritan Bennett 560 Ventilator.

Table 2-13. Compliant Cables and Accessories

Cable or accessory	Maximum length
P/N 2981499 Mains power cord, Australia	5.74 ft (1.75 m)
P/N 2977099 Mains power cord, Canada	5.74 ft (1.75 m)
P/N 2971899 Mains power cord, UK	5.74 ft (1.75 m)
P/N2972099 Mains power cord, Japan	5.74 ft (1.75 m)
P/N 2972399 Mains power cord, China	5.74 ft (1.75 m)
P/N 2972499 Mains power cord, SAF/India	5.74 ft (1.75 m)
P/N 2971799 Mains power cord, EU	5.74 ft (1.75 m)
P/N various, contact your local representative (PN 10003736, Brazil) Mains power cord, Latin America	5.74 ft (1.75 m)
P/N 10094626 Remote alarm cable	16.40 ft (5 m)
P/N 10094625 12V cable (for connection to automobile DC power port)	4.26 ft (1.3 m)

2.7 Tools, Equipment, and Service Materials

Table 2-14 lists the tools, equipment, and service materials needed to service the Puritan Bennett 560 Ventilator. All test equipment used by Covidien service personnel shall be calibrated and maintained in accordance with Field Service quality system procedures.

Note:

Part numbers are subject to change.

Table 2-14. Tools, equipment, and service materials

Tool	Manufacturer/model or COVIDIEN part number	Where used
Bacteria filters (x2)	See Table 2-2 for recommended part numbers	Performance verification
Barbed coupling, silicone, 22mm ID (quantity 3)	4-003443-00	Performance verification
Calibration shell	S-231702-00B or equivalent	Performance verification
Connector, 22 mm barbed to 22 mm conical	4-018075-00	Performance verification
DC power supply adjustable, 0-18 VDC, 0-3 Amps	Extech model 382202 or equivalent	Performance verification
DC test cable	10000021 modified to attach to 12 V power supply	Performance verification (ventilator/safety tester connection)
Digital multimeter (DMM) with 3 decimal place resolution	Fluke 87 or equivalent	Performance verification
Disinfectant/cleaner	The following cleaners/disinfectants are suitable for use on the exterior surfaces of the Puritan Bennett 560 Ventilator: Mild dishwashing detergent 70% isopropyl alcohol (rubbing alcohol) 10% chlorine bleach (90% tap water) Glutaraldehyde Hospital disinfectant cleaners (phenolic-based: o-Phenylphenol 10.5%, o-Benzyl-p-chlorophenol 5.0%; Amphyl or equivalent) Hydrogen peroxide 15% ammonia (85% tap water) Ammonia based household cleaners Household cleaners (Alkyl Dimethyl Benzyl Ammonium Chloride 0.3%, 409 or equivalent)	General cleaning
Electrical safety analyzer	Fluke ESA 620 or equivalent analyzer capable of performing electrical safety tests for Class II, Type BF equipment.	Performance verification
Electrostatic shielding bags 8 x 5 in. (20.3 x 12.7cm) 11 x 14 in. (27.9 x 35.6 cm) 18 x 14 in. (45.7 x 35.6 cm	 4-009803-00 4-009800-00 4-009801-00	General servicing of electronics

Table 2-14. Tools, equipment, and service materials (continued)

Tool	Manufacturer/model or COVIDIEN part number	Where used
FiO_2 sensor measurement kit (attached to UUT)	3814199	Performance verification
Flex tube (standard tube), 22 mm x 21.0 in.	4-018506-00	Performance verification
Ground test cable	10000017	Performance verification (ventilator/safety tester ground connection)
Leak detector solution	4-004489-00	Leak testing oxygen solenoid valve connections
Oxygen connector, male	2962700	Performance verification
Patient circuit tubing, dual limb, adult	5094000	Performance verification
Patient circuit tubing, dual limb, pediatric	5093900	Performance verification
Patient circuit tubing, single limb, adult	5093600	Performance verification
Patient circuit tubing, single limb, pediatric	5093500	Performance verification
Patient lead test cable	Supplied with Fluke ESA 620	Performance verification (electrical safety test)
Personal computer with Windows OS and also USB capability	Local supplier	Software upload to ventilator Event log download from ventilator Performance verification
Power cord assembly	2977099	Performance verification
PTS 2000 Pneumatic Calibration Analyzer	4-076185-00	Performance verification
Puritan Bennett™ 500 Series Ventilator Test Software	10059515	Performance verification
Remote alarm test box	10000019 (compatible with RAI remote alarm harness black plastic connector) 10005329 (compatible with RAII remote alarm harness gray metallic connector)	Performance verification

Table 2-14. Tools, equipment, and service materials (continued)

Tool	Manufacturer/model or COVIDIEN part number	Where used
Silicone tubing, 7/32" ID (5 to 6 mm ID), various lengths	Local supplier	Performance verification
Standard exhalation block	10046892	Performance verification
Standard tool kit including: Hexalobular (Torx®) drivers sizes T8, T9, T10, T20 #1 Phillips screwdriver Needle nose pliers Small flat bladed screwdriver Tie wraps Cable cutter	Local supplier	Service and repair
Static-dissipative field service kit (includes wrist strap, static dissipative mat, and ground cord)	4-018149-00 or equivalent	General servicing of electronics
Stopper, no. 1	4-009523-00	Performance verification
Stopper, no. 2	G-061574-00	Performance verification
Test lung, Covidien	LNG800P or equivalent	Performance verification
Test lung, 4L	4-075578-00 or equivalent	Performance verification
Tubing connector, 3/16 to 1/8	4-006104-00 or equivalent	Performance verification
Tubing junction, 22 mm OD, with pressure port	4-011521-00	Performance verification
Tubing, silicone, 1/8 ID, 6 in.	4-008578-00	Performance verification
Tubing, silicone, 3/16 ID, 3 ft.	4-008577-00	Performance verification
USB cable, mini type B	10094627 or equivalent	Software upload to ventilator Event log download from ventilator
USB memory device (128 MB minimum memory requirement and formatted in the 32-bit file format)	Local supplier	Performance verification

2.8 Preventive Maintenance

Caution

- To prevent component damage due to excessive wear, perform preventive maintenance and replace components at recommended intervals, as indicated in Table 2-15. You may find it convenient to note anticipated replacement dates for all components based on typical usage rates or recommended intervals.
- Covidien has determined the Puritan Bennett 560 Ventilator preventive maintenance schedule based on the life expectancies of ventilator parts. Be aware that these parts, listed below, could also require unscheduled corrective maintenance and that other parts, not listed, could also require corrective maintenance during your ventilator's lifetime.

Table 2-15 lists the periodic maintenance activities required for the Puritan Bennett 560 Ventilator. You can find the total machine hours on the welcome screen that appears when you turn on the power switch, in the preferences screen in normal operation, and also when you enter Maintenance mode (refer to Section 2.12 for information on how to enter Maintenance mode.)

Table 2-15. Preventive Maintenance Schedule

Frequency	Part	Maintenance
As needed	Ventilator external surface	Clean and disinfect. Refer to Section 5.6.1 ventilator cleaning instructions.
	Ventilator dual bag	Clean dual bag regularly (can be machine washed).
According to institutional protocol and/or manufacturer recommendation	Inspiratory bacteria filter	Replace.
	Exhalation bacteria filter	
	Patient circuit	
With each new patient	Inspiratory bacteria filter	Replace.
	Exhalation block	Replace. Recalibrate exhalation flow sensor if replaced. See Section 6.7.3 for calibration instructions.
	Exhalation bacteria filter	Replace.
	Patient circuit	Replace.

Table 2-15. Preventive Maintenance Schedule (continued)

Frequency	**Part**	**Maintenance**
Check or replace once per month or more often.	Inlet air filter	Replace. **Note:** In particularly dusty environments, replace the inlet air filter more frequently to prevent clogging even if the preventive maintenance period has not elapsed. Refer to Section 5.7.1 for inlet air filter replacement instructions.
Every four months or with each new patient	Exhalation block* * See Clinician's manual	Replace exhalation block and calibrate exhalation flow sensor after re-installation of exhalation block. Refer to Section 5.7.5 for exhalation block replacement instructions. Refer to Section 6.7.3 for calibration instructions.
Every 15,000 hours of use	Oxygen solenoid valve	Replace. Refer to Section 5.7.18 for oxygen solenoid valve removal and replacement instructions.
	Turbine	Refer to Section 5.7.19 for turbine removal and replacement instructions.
	Exhalation solenoid valve	Replace. Refer to Section 5.7.9 for exhalation solenoid valve removal and replacement instructions.
	Cooling fan	Replace. Refer to Section 5.7.23 for cooling fan removal and replacement instructions.

Table 2-15. Preventive Maintenance Schedule (continued)

Frequency	Part	Maintenance
Every two years	Clean and disinfect Insp block	*Clean and disinfect the inspiratory block using one of the disinfectants listed in Table 2-14. Re-calibrate insp flow sensor Reference Section 6.7.3.2 for inspiratory flow sensor calibration instructions.
	Measurements check and calibration	Refer to Section 6.7.2 and Section 6.7.3 for measurements check and calibration instructions.
	Battery, lithium-ion 4.8 Ah memory	Replace. Refer to Section 5.7.4 for battery removal and replacement instructions.
	Battery, lithium, 3V	Replace. Refer to Section 5.7.12 for 3V battery removal and replacement instructions.
	Buzzer PCBA	Replace. Refer to Section 5.7.15 for buzzer PCBA removal and replacement instructions.

*To prevent cross contamination, both cleaning and disinfection of the inspiratory block and flow sensor calibration should be considered before new patient use in the event that filters were not used at the inspiratory port or proximal Y piece.

Table 2-16. Preventive Maintenance Parts List

Part description	Part number
Battery, lithium, 3V	10022884
Battery, lithium-ion 4.8 Ah memory	10087047 (Requires minimum version power management software AL020002)
Buzzer PCBA	10108395
Cooling fan	10028754
Exhalation block	10046892
Exhalation solenoid valve	3818699
Inlet air filter (6 pk)	10028771
Oxygen solenoid valve	10028763
Turbine	10028768

2.9 Controls, Indicators, and Interfaces

This section lists the Puritan Bennett 560 Ventilator controls, indicators, and interfaces.

Figure 2-1. Control Panel

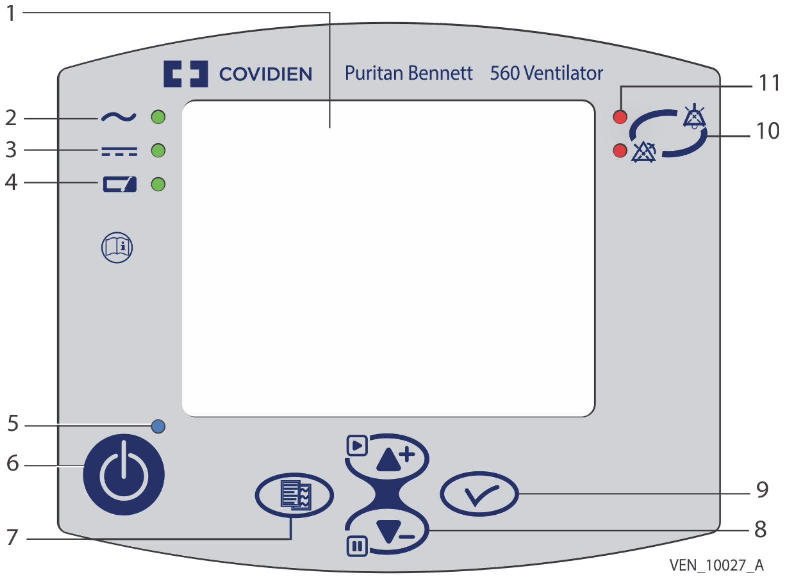


Table 2-17. Control Panel Keys and Indicators

Index Figure 2-1	Labeling	Function
1	N/A	**LCD panel.** Displays ventilation modes and parameters, waveforms, alarms, and ventilator configuration information.
2	∼	**AC power indicator.** When lit, green LED indicates ventilator is connected to AC power.
3	⎓	**DC power indicator.** When lit, green LED indicates ventilator is connected to an external DC power source (e.g., automobile cigarette lighter or power port).

Table 2-17. Control Panel Keys and Indicators (continued)

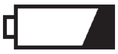
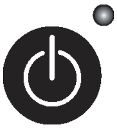
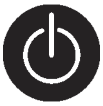
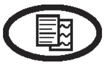
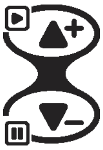
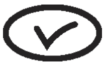
Index Figure 2-1	Labeling	Function
4		**Internal battery indicator.** When lit, green LED indicates ventilator is operating on internal battery power if no other power source is connected. LED flashes when the internal battery is charging, and turns off when the battery is charged.
5		**Ventilator status indicator.** When lit, blue LED indicates ventilator is in standby mode, and enables the user to locate the Ventilation ON/OFF key at night. During ventilation, LED is off.
6		**Ventilation ON/OFF key.** Press and release key to start ventilation. Press and hold key for 3 seconds to stop ventilation. Confirm stop by pressing the **Ventilation ON/OFF** key again.
7		**Menu key.** Use this key to switch between the ventilator parameters, alarm settings, and waveform screens. When a USB memory device is inserted into the USB port, this key activates the USB memory device screen.
8		**Up/down arrow and unfreeze/freeze waveform keys.** Up arrow key moves the cursor upward in a menu, increases a setting value when a parameter is selected, or activates the waveform display (unfreeze) when viewing waveforms. Down arrow key moves the cursor downward in a menu, decreases a setting value when a parameter is selected or freezes the waveform on the screen when viewing waveforms.
9		**Enter key.** Accepts a setting or enables selections within a submenu.

Table 2-17. Control Panel Keys and Indicators (continued)

Index Figure 2-1	Labeling	Function
10	🔕	**Alarm control key.** Press and release once to pause the audio portion of the alarm for 60 s. Press and release twice to activate the alarm paused function. When alarm paused is active, visual and audible alarm signals are suspended until a new alarm becomes active.
11	● ●	**Alarm indicators.** Red LED indicates an active high priority alarm. Yellow LED indicates active medium priority alarms.

Figure 2-2. Front View

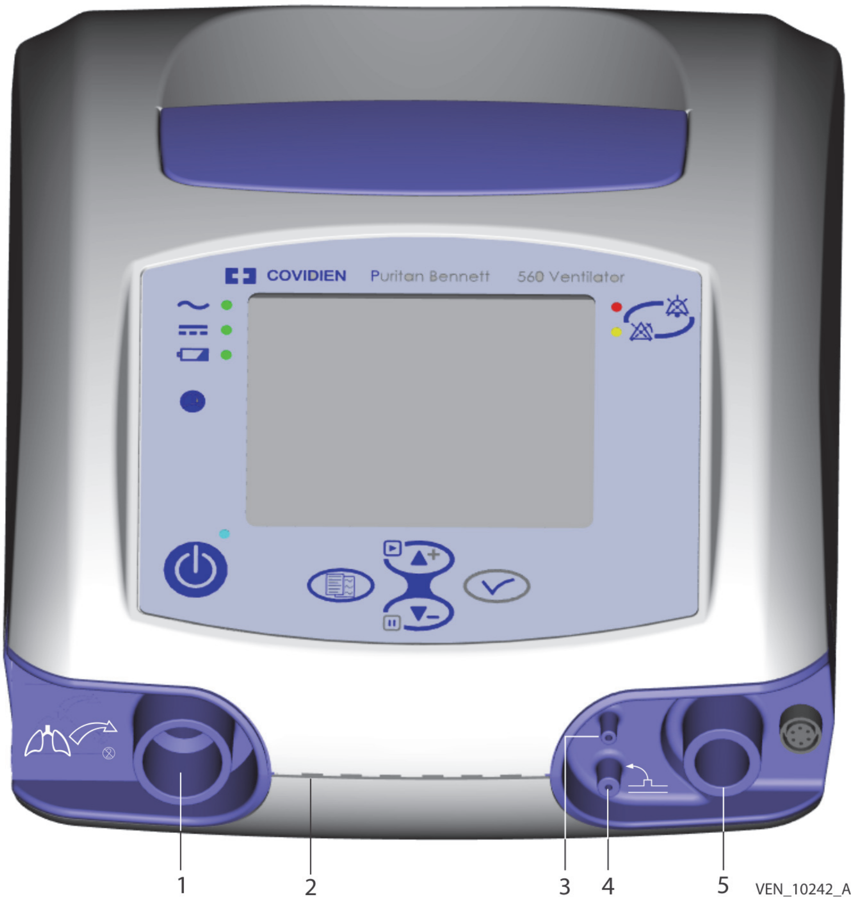


Table 2-18. Front Panel

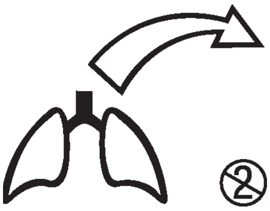
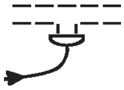
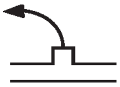
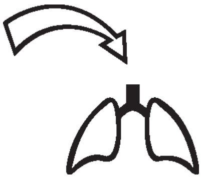
Index Figure 2-2	**Labeling**	**Function**
1		**Exhalation block from-patient port.** Gas return port to which exhalation limb of double-branch patient circuit connects for exhaled volume measurements. **Single patient use:** Do not use the exhalation block on multiple patients.
2	N/A	**Front air vent.** Allows air flow through the ventilator for electronics cooling.
3		**Exhalation valve pilot port.** Port used to apply pressure to the exhalation valve diaphragm.
4		**Patient proximal pressure port.** Port for measuring patient pressure.
5		**To patient port.** Gas output port to which inspiratory limb of double-branch patient circuit connects.

Figure 2-3. Rear View

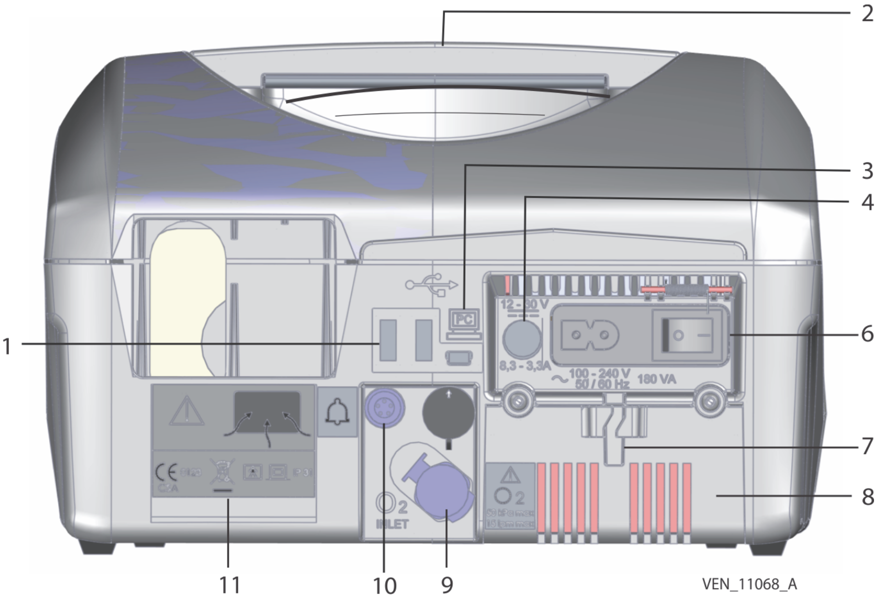

2
3
4
6
1
7
8
11
10
9
PC
12 - 30 V
8,3 - 3,3A
100 - 240 V
50 / 60 Hz
180 VA
O2
INLET
VEN_11068_A

Table 2-19. Rear Panel Labels and Markings

Index Figure 2-3	**Labeling**	**Function**
1		**USB ports.** Two Type-A receptacles designed to use a 32-bit formatted USB memory stick.
2	N/A	**Carrying handle.** Handle is integrated into the top housing.
3	PC	**PC communication port.** One USB Type B mini receptacle for connection to a personal computer (PC). Used for software uploads and data downloads.
4	12 - 30 V ⎓ 8,3 - 3,3 A	**DC power cord connector.** Keyed connector for DC power cord.

Table 2-19. Rear Panel Labels and Markings (continued)

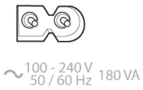
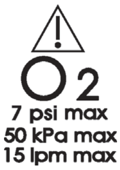
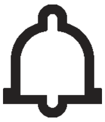
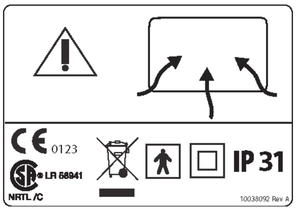
Index Figure 2-3	Labeling	Function
5	 100 - 240 V 50 / 60 Hz 180 VA	**AC power cord connector.** Connector for AC mains power.
6	I/O	**ON/OFF switch.** Applies/removes power to the ventilator. Protective cover prevents accidental switch actuation.
7	N/A	**Power cord retainer.** Prevents inadvertent power cord disconnection.
8	N/A	**Internal battery cover.** Provides access to internal battery.
9	 O 2 7 psi max 50 kPa max 15 lpm max	**Oxygen connector.** Connector for low pressure oxygen line.
10		**Nurse call connector.** Connector for nurse call cable.
11	 0123 LR 58941 NRTL /C IP 31 10038092 Rev A	**Air inlet label.** Identifies ventilator air inlet. See Table 2-22 for description of individual symbols.

Figure 2-4. Top View

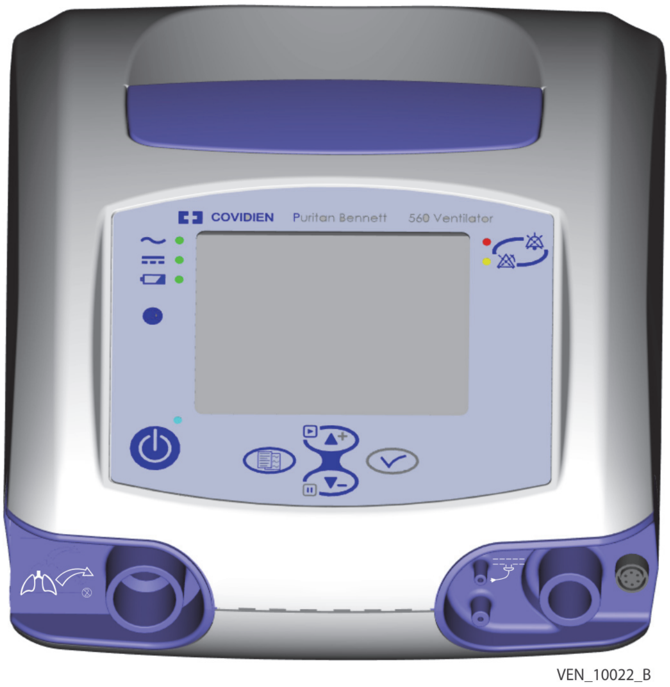
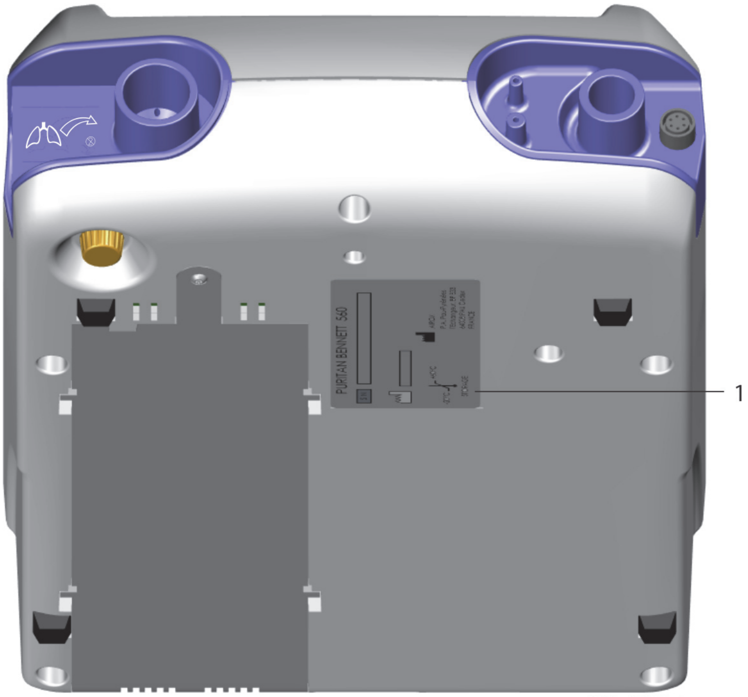

COVIDIEN
Puritan Bennett
560 Ventilator
VEN_10022_B

Figure 2-5. Bottom View



VEN_12111_A

Table 2-20. Bottom Panel Labels

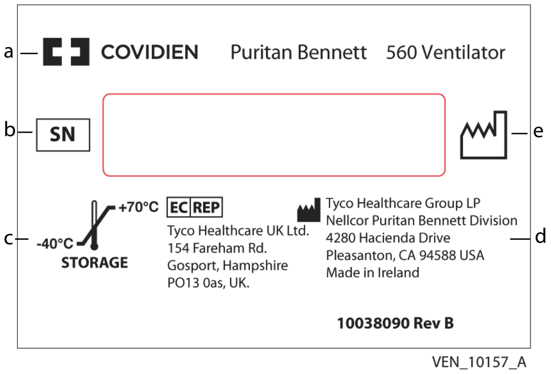
Index Figure 2-5	Labeling	Function
1	 COVIDIEN Puritan Bennett 560 Ventilator SN +70°C -40°C STORAGE EC REP Tyco Healthcare UK Ltd. 154 Fareham Rd. Gosport, Hampshire PO13 0as, UK. Tyco Healthcare Group LP Nellcor Puritan Bennett Division 4280 Hacienda Drive Pleasanton, CA 94588 USA Made in Ireland 10038090 Rev B VEN_10157_A	**Product Identification label:** a: Device name/model b: Serial number c: Storage temperature range d: Manufacturer name and address, country of origin e: Manufacture date (year)

Figure 2-6. Side View

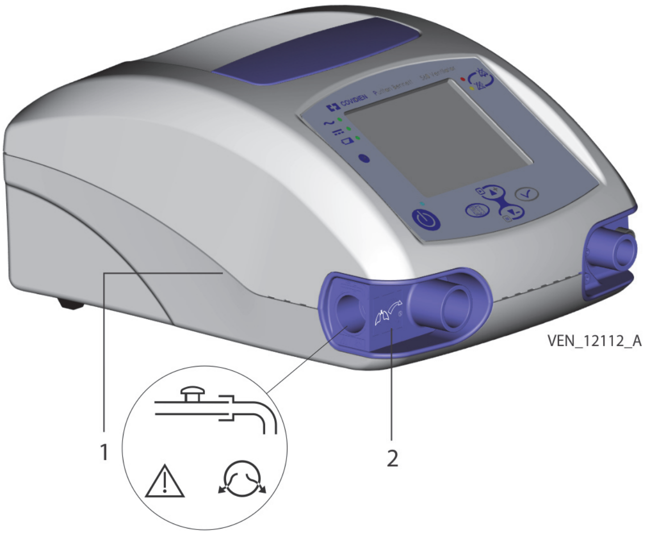


Table 2-21. Side Panel

Index Figure 2-6	Labeling	Function
1	N/A	**Side air vents.** Allow air flow through the ventilator for electronics cooling.
2	See Figure 2-6	**Exhaled gas outlet port.** Allows exhaled flow to exit the ventilator through the patient circuit exhalation valve (when dual limb circuit is used).

2.10 Symbols, Abbreviations, and Internal Labels

The following table lists symbols and abbreviations found on the Puritan Bennett 560 Ventilator screens or on the device or its labels, and contains labels not referenced in Figure 2-1 through Figure 2-3.

Table 2-22. On-screen symbols, abbreviations, and internal labels

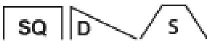
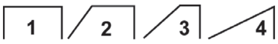
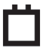
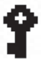
Symbol	Meaning
Symbols found on ventilator screens	
	**Flow pattern.** In VAC mode only, you can select between square (SQ), descending ramp (D), or sinusoidal (S) flow patterns. In volume ventilation mode, you can select between square (SQ) and descending ramp (D) flow patterns.
	**Pressure rise times.** In pressure ventilation modes, you can select one of four rise times: Setting 1 = fastest Setting 2 Setting 3 Setting 4 = slowest To avoid invalid settings, the rise time will automatically adjust to ensure the set inspiratory time is less than rise time setting + 300 ms.
	Freeze indicator. Appears on the waveforms screen when the waveform tracing has been frozen.
	**Battery capacity indicator.** Battery capacity appears as a percentage of full charge.
	**Software lock enabled.** Access to ventilator patient settings, preferences menu, alarm settings, and maintenance mode is not permitted. There is access, however, to the ventilation menu, alarm menu, waveforms menu, USB menu, alarm memory menu, and play/ pause of the breath delivery waveforms. To lock or unlock the ventilator: With the ventilator in standby or ventilation mode, simultaneously press and hold the up and down arrow keys for 3 seconds.
■	**Cursor.** Shows cursor's current position.
□	**Available parameter.** Parameter may be selected when device is not locked.
–	**Unavailable parameter.** Parameter cannot be changed when device is locked.
±	**Setting adjust indicator.** Appears when you select a parameter for adjustment.
●	**Breath trigger indicator.** Indicates a patient-initiated inspiration.
	Exhalation valve presence indicator. Indicates an exhalation valve is present in the patient circuit (valve configuration). Displayed on title line of ventilator screen.

Table 2-22. On-screen symbols, abbreviations, and internal labels (continued)

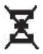
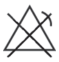
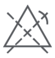
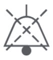
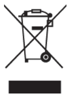
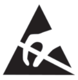
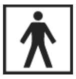
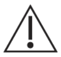
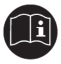
Symbol	Meaning
	**Exhalation valve absence indicator.** Indicates an exhalation valve is not present in the patient circuit (leakage configuration). Displayed on title line of ventilator screen.
	**Alarm off (Apnea off) indicator.** Indicates apnea alarm as been set to OFF in the Preferences menu. Displayed on title line of ventilator screen.
	**Alarm paused indicator.** Indicates an alarm paused condition. Displayed on title line of ventilator screen.
	**Audio paused indicator.** Indicates an audio paused condition. Displayed on title line of ventilator screen.
Apnea time	Time interval after which the ventilator detects an apnea condition.
CV (V A/C)	Volume Assist/Control Ventilation mode
PC (P A/C)	Pressure Assist/Control Ventilation mode
PSV/ (ST)	Pressure Support Ventilation
V SIMV	Volume Synchronized Intermittent Mandatory Ventilation mode
P SIMV	Pressure Synchronized Intermittent Mandatory Ventilation mode
CPAP	Continuous Positive Airway Pressure mode
Symbols and markings found on ventilator surfaces or labels	
	Recycle electrical and electronic items with this marking according to local regulations (EN50419). Do not discard with ordinary household waste. This includes the ventilator and the battery.
	Electrostatic sensitive devices label (IEC 60417-5134). Located on inside of lower housing near Power Management PCBA. Observe necessary precautions when handling devices sensitive to electrostatic discharge (ESD).
	Type BF applied part (IEC 60417-5333). A regulatory standard classification for protection against electrical shock for the part of the device that contacts the patient.
	Attention - consult accompanying documents (ISO 7000-0434A).
	Consult instructions for use (ISO 7000-1641).

Table 2-22. On-screen symbols, abbreviations, and internal labels (continued)

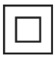
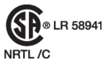
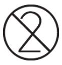
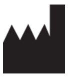
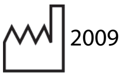
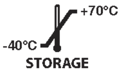
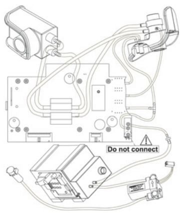
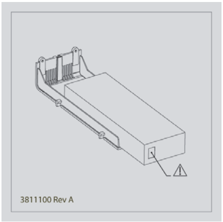
Symbol	Meaning
	Insulation class II equipment (IEC 60417-5172). A regulatory standard classification for protection against electric shock. Equipment in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions such as double insulation or reinforced insulation are provided, there being no provision for protective earthing or reliance upon installation conditions.
	CSA certification mark that signifies the product has been evaluated to the applicable Underwriters Laboratories Inc. (UL) and CSA standards for use in the US and Canada.
IP 31	Ingress protection classification. Protected against access to hazardous parts with a tool. Protected against solid foreign objects of 2.5 mm diameter and greater. Protected against vertically falling water drops.
	Do not reuse. Single patient use (ISO 7000-1051).
	Manufacturer (BS EN-980)
	Manufacture date (ISO 7000-2497).
	Storage temperature range (ISO 7000-0632)
ATTENTION **⚠ CAUTION** **∼100-240V**	Mains warning label (located on Power Management PCBA power supply guard)

Table 2-22. On-screen symbols, abbreviations, and internal labels (continued)

Symbol	Meaning
	Pneumatic cable routing diagram label (located on inside top housing)
	Battery installation label (located inside battery cover)

2.11 Serial Number and Software Versions

The serial number can be found on the label on the bottom of the ventilator or on the Maintenance mode screen. The CPU and Power Management software versions appear on the welcome screen for approximately 10 seconds after turning the ventilator's power switch on. When the ventilator is in Maintenance mode the CPU and Power Management software versions are displayed on the screen (see Section 2.12 for instructions on how to enter Maintenance mode).

2.12 Ventilator Configuration

The Setup screen allows you to configure the following parameters:

- Language: English, English (US), Spanish, French, Greek, Italian, Japanese, Korean, Netherlands, Norwegian, Polish, Portuguese, Russian, Finnish, Swedish, Turkish, Chinese, Danish, German.
- Date: DD MMM YYYY format
- Time: HH:MM:SS format
- Intentional Vent Stop: YES or OFF
- Pressure unit: cmH_2O, mbar, hPa
- Alarm Tone: Compliant (softer) or Original (louder)
- Patient hours: XXXXX h XX min
- Reset hours: YES or OFF

- Restore Defaults: YES or OFF

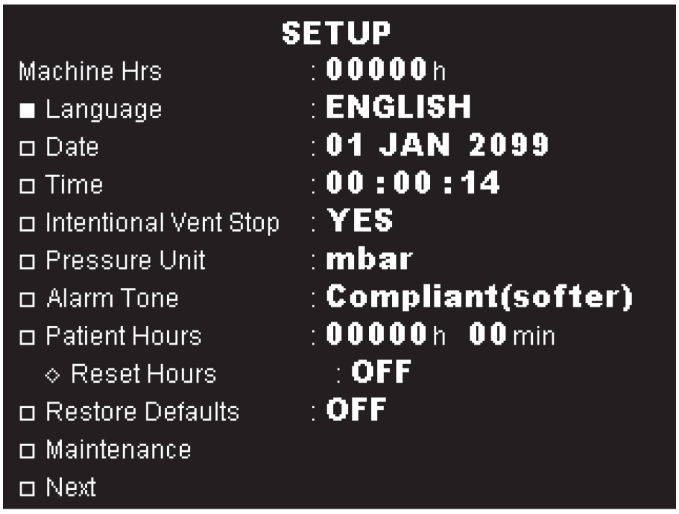
  This parameter allows the user to reset all settings back to the original manufacturer defaults, except for the Language, Date, and Time.
- Maintenance
- Next

Any settings changes are retained in the ventilator's memory after the ventilator is turned off.

To access the Setup screen and Maintenance mode:

1. Ensure the ventilator's power switch is in the OFF position.
2. Press and hold the **ALARM CONTROL** key while simultaneously switching the ventilator to the ON position. Continue holding the key until the Setup screen appears (Figure 2-7).

Figure 2-7. Setup Screen



SETUP

Machine Hrs : 00000h

■ Language : ENGLISH

☐ Date : 01 JAN 2099

☐ Time : 00 : 00 : 14

☐ Intentional Vent Stop : YES

☐ Pressure Unit : mbar

☐ Alarm Tone : Compliant(softer)

☐ Patient Hours : 00000h 00min

◇ Reset Hours : OFF

☐ Restore Defaults : OFF

☐ Maintenance

☐ Next

VEN_10164_B

Note:
If the ventilator fails to enter SETUP, stop ventilation by pressing the Ventilation ON/OFF key for 3 seconds and pressing again to confirm stop. Power off the ventilator then repeat steps 1 and 2 above.

To change the language, date, time, or other settings

1. Use the **UP** or **DOWN** arrow keys to place the cursor at the desired position and press **ENTER**.
2. Use the **UP** or **DOWN** arrow keys to change settings.
3. Press **ENTER** to confirm your selection.

Note:

- When a parameter contains several setup fields (e.g., Date, Time) press **ENTER** to move from one field to the next.
- If a change is not confirmed with **ENTER** after 7 seconds, the ventilator restores the previous value.

To change the alarm tone:

1. Use the **UP** or **DOWN** arrows to place the cursor on "Alarm Tone."
2. Press **ENTER**.
3. Use the **UP** or **DOWN** arrows to select **Compliant** or **Original**.

   The default setting is Compliant. The audible sound of Compliant is softer than the Original tone, and meets the requirements of standard EN-60601-1-8. Original refers to the alarm tone that was shipped with the ventilator from initial release until the LX010023/LX010101 software update.
4. Press **ENTER** to confirm the selection.

To reset patient hours:

1. Use the **UP** or **DOWN** arrow keys to place the cursor at the "Patient Hours" position.
2. Press **ENTER**. The cursor moves to the "Reset Hours "position.
3. Press **ENTER**. "OFF" flashes.
4. Press the **UP** or **DOWN** arrow key to change the message to "YES".
5. Press **ENTER**. "YES" appears continuously, a long "beep" sounds, and the patient counter display resets to 00000 h 00 min and the display shows "Reset Hours: OFF".

To restore the default settings:

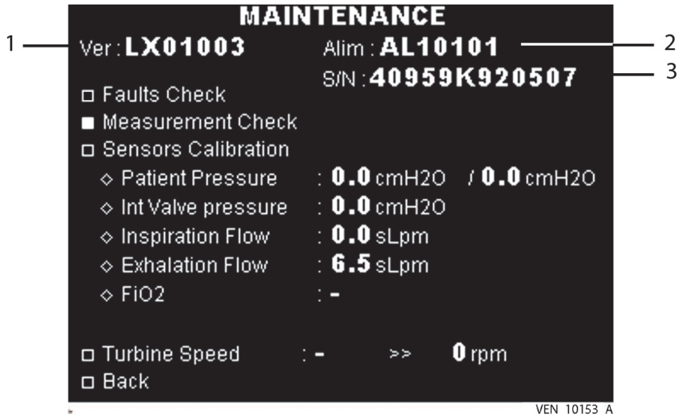
1. Use the **UP** or **DOWN** keys to place the cursor on "Restore Defaults."
2. Press **ENTER**. "OFF" flashes.
3. Press **UP** or **DOWN** to change "OFF" to "YES."
4. Press **ENTER** to reset all settings back to the manufacturer defaults except for Language, Date, and Time. "OFF" will reappear.

To enter Maintenance mode:

1. Press the **DOWN** arrow key to place the cursor at the "Maintenance" position.
2. Press **ENTER**. The Maintenance screen appears.
3. To go back to the Setup screen, press the **UP** or **DOWN** arrow key to place the cursor at the "Back" position.
4. Press **ENTER** to return to the Setup screen.

Once the ventilator is in Maintenance Mode, a menu appears with the following selections (Figure 2-8):

Figure 2-8. Maintenance Screen



MAINTENANCE

Ver : **LX01003** Alim : **AL10101**

S/N : **40959K920507**

☐ Faults Check

■ Measurement Check

☐ Sensors Calibration

◇ Patient Pressure : **0.0** cmH2O / **0.0** cmH2O

◇ Int Valve pressure : **0.0** cmH2O

◇ Inspiration Flow : **0.0** sLpm

◇ Exhalation Flow : **6.5** sLpm

◇ FiO2 : -

☐ Turbine Speed : - >> **0** rpm

☐ Back

1 Ventilator software version

2 Power management CPU software version

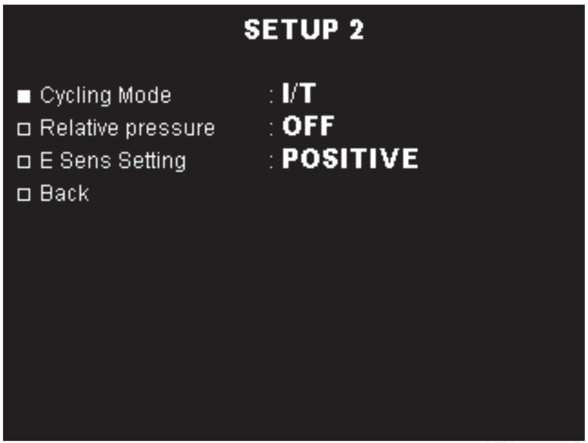
3 Ventilator serial number

- Faults check
- Measurement check
- Sensors calibration including a submenu with Patient pressure, Int valve pressure, Inspiration Flow, and Exhalation Flow
- Turbine speed
- Back

To access the Setup 2 menu:

1. Press the **UP** or **DOWN** arrows to place the cursor beside “Next.”
2. Press **ENTER**. The Setup 2 menu is displayed.

Figure 2-9. Setup 2 Menu



SETUP 2

■ Cycling Mode : I/T

☐ Relative pressure : OFF

☐ E Sens Setting : POSITIVE

☐ Back

VEN_10164_C

The parameters in this menu are:

- Cycling Mode: I:E or I/T

  I:E ratio is the ratio of inspiratory time to expiratory time. I/T is the inspiratory time divided by the total breath cycle expressed as a percentage. The mode that uses this value is P A/C.

- Relative Pressure: OFF or YES.
- E Sens Setting: Positive, Negative
- Back

  The Back parameter allows the user to return to the Setup menu.

2.13 Service Philosophy

Field service of the ventilator is limited to the service activities described in this manual. For field service, technical support, or information on technical training, contact your local Covidien representative.

Servicing the Puritan Bennett 560 Ventilator consists of a three-step process (Figure 2-10).

Figure 2-10. Service Process

Troubleshoot ventilator
Repair device or perform preventive maintenance
Final performance verification

1. **Troubleshoot the ventilator (as required)** — Determine the cause of the problem and what components or assemblies need to be replaced. Use the information in Chapter 4 to diagnose ventilator malfunctions.
2. **Repair the ventilator or perform preventive maintenance** — See the schedule in Table 2-15 of this chapter for preventive maintenance intervals. Chapter 5 contains step-by-step instructions for disassembly, component repair or replacement, and reassembly.
3. **Final performance verification** — Calibrate the ventilator's sensors and check the ventilator's performance characteristics after servicing as described in Chapter 6 to ensure all problems have been corrected and no new problems have been introduced.

3 Theory of Operation

This chapter contains the theory of operation of the Puritan Bennett™ 560 Ventilator and includes the following information:

- overview of ventilator operation and the ventilator's safety net
- description of the ventilator components and their interactions during breath delivery
  - pneumatic system description
  - electrical system description.

3.1 Operational Overview

When you turn the ventilator on, Power On Self Test (POST) automatically runs during the first 15 seconds. During this period, the ventilator checks the status of AC and internal battery power sources, tests the LEDs and alarms, and checks the integrity of memory. The LCD panel displays device and patient hours, ventilator software version, date, time, and copyright information. If POST fails, the ventilator resorts to a safe state where ventilation is not allowed: the exhalation valve opens, the turbine stops, the alarm sounds continuously, and the ventilation stand-by LED flashes. When POST passes, the ventilator remains in Standby mode until you press the Ventilation ON/OFF key to start ventilation. When ventilation is started, the software automatically performs a turbine speed test.

The keyboard is used to enter breath delivery and patient alarm settings into the ventilator and to enter Maintenance mode — a non-ventilatory mode reserved for sensor calibrations and other performance checks. The keyboard is also used to set a software lock to prevent inadvertent changes to the prescribed settings. (Refer to Section 4.3.2 for instructions on how to enable and disable the software lock.) Ventilator and alarm settings are retained in non-volatile memory during periods when the ventilator is turned off.

Breath delivery is based on a closed loop control system that adjusts the speed of the turbine. The speed of the turbine is controlled to the patient pressure signal or the inspired flow signal depending on whether pressure ventilation or volume ventilation is selected. The turbine speed control algorithms vary according to the ventilation mode, ventilator settings and whether the ventilator is in an inspiratory or expiratory phase. The speed of the turbine adjusts under software control during the expiratory phase to maintain the set PEEP level. Setting the pressure rise time or flow pattern influences the level of turbine acceleration at the start of inspiration. The transition between the inspiratory and expiratory phase is controlled by a deceleration or braking action proportional to the pressure difference between the two phases.

Flow-triggering algorithms, using measurements from an inspiratory flow sensor detect when inspiration begins and also determine the end of the inspiration phase when the ventilator is in PSV ST mode. When altitude compensation is turned on (default setting), the flow measurement is automatically corrected as a function of the atmospheric pressure measured by the ventilator's internal barometer, btps reference temperature, and standard pressure and temperature references.

The turbine spins continuously throughout the breath, creating flow in the patient circuit. The exhalation valve, located at the outlet of the exhalation block on Puritan Bennett 560 Ventilator, is fully closed during the inspiratory phase. A three-way solenoid valve on the CPU PCBA controls the pressure to the exhalation valve during the expiratory phase to allow purge and bias flows (created by the spinning turbine) to clear the patient circuit of exhaled gas. When a dual limb patient circuit is used, exhaled flow is measured by an exhalation flow sensor on the CPU PCBA via a port located in the exhalation block. This flow measurement is used to calculate the expired tidal volume.

Inspiratory and exhalation volumes are reported in body temperature and pressure saturated (BTPS) units when altitude compensation is set to YES, and ambient temperature and pressure dry (ATPD) units when altitude compensation is set to OFF. It is recommended to always set altitude compensation to YES. BTPS reference temperature is 37°C, and BTPS reference pressure is 1013 hPa (1033 cmH_2O).

The various measurement signals used in control and detection are electronically filtered in order to minimize electrical noise and prevent erroneous alarms.

Consult the *Puritan Bennett 560* Ventilator *Clinician's Manual* for a detailed description of breath delivery in each mode.

3.2 Safety Net

The ventilator uses software and hardware features to prevent and detect conditions that could adversely affect the patient's safety or the safety of the device.

A multiple priority alarm system is designed into the ventilator that includes operator-selectable low and high limits for breath delivery parameters, and built-in, non-adjustable alarms that can detect and announce unsafe patient conditions and various potential ventilator malfunctions. Alarms are indicated by audible alarm tones, flashing LEDs on the ventilator's control panel, and current alarm message displays on the ventilator settings and alarm screens. A secondary audio alarm source is available in the event of failure of the primary alarm. The backup alarm can be tested in the Measurements Check menu of Maintenance Mode. Past alarms and technical faults can be viewed from the LCD screen or downloaded to a computer using Puritan Bennett™ 500 Series Ventilator Test Software. The alarm system is explained in detail in Chapter 4.

Watchdog monitors exist to ensure correct operation for microprocessors, data acquisition channel integrity, and A/D reference voltage accuracy. Software checks these watchdogs and will trigger alarms if out-of-range values are found.

Sensors measure the internal ventilator temperature and turbine temperature and the CPU monitors these temperatures within specified limits. Internal temperatures are also used to control the speed of the fan inside the ventilator. As temperatures rise, the fan's speed increases. If temperatures go beyond safe limits, the ventilator stops ventilation and sounds an alarm.

To guard against potential high pressure conditions, software monitors the pressure transducers and will declare a high pressure alarm if any of the following conditions occur:

- inspiratory pressure is higher than the set high PIP limit
- inspiratory pressure is greater than the set inspiratory pressure + 5 cmH_2O for pressures less than or equal to 29 cmH_2O
- inspiratory pressure is greater than the set inspiratory pressure + 10 cmH_2O for pressures from 30 to 60 cmH_2O
- inspiratory pressure is greater than 60 cmH_2O
- expiratory pressure is greater than the limits described above for longer than 100 ms.

An internal pressure sensor monitors the pressure at the ventilator outlet to provide a backup for pressure measurements if the proximal pressure tubing becomes disconnected.

If a high pressure condition occurs during inspiration, the ventilator immediately switches to exhalation. If the high pressure occurs during exhalation, the exhalation valve is opened fully and the turbine stops.

Supplemental oxygen is available via the oxygen inlet connector (maximum 7 psi or 15 lpm). The oxygen inlet connector uses an internal valve to prevent leaks when connecting and disconnecting an oxygen supply.

Ventilator parameters and alarm limits are linked to prevent incompatible settings adjustments. Table 2-4 lists the dependencies for each parameter.

In the event of a ventilator shut-down, the system is designed so that the exhalation valve remains open and that the patient can breathe room air through the turbine inlet and both limbs of the patient circuit.

A software lock is available to prevent inadvertent changes of ventilator settings. (refer to Section 4.3.2 for instructions on how to enable and disable the software lock.)

A power switch cover is provided to prevent the ventilator from accidentally being switched off, and an alarm is present that annunciates if the ventilator is switched off using the power switch instead of stopping ventilation with the keypad first, then turning off power.

3.3 Ventilator Components

The Puritan Bennett 560 Ventilator provides positive pressure ventilation using an electronically controlled micro-turbine to deliver air and supplemental oxygen to the patient. The two main systems that comprise the Puritan Bennett 560 Ventilator are the pneumatic system and the electronic system.

3.4 Pneumatic System

This section describes the components of the pneumatic system. Figure A-1 shows a pneumatic block diagram of the Puritan Bennett 560 Ventilator, including the patient circuit.

Table 3-1 lists the main pneumatic components and their operating ranges.

Table 3-1. Pneumatic Component Operating Ranges

Component	Operating range
Inspiratory flow sensor	0 to 1000 sccm
Exhalation flow sensor	0 to 1000 sccm
Proximal pressure sensor	-10 to 100 cmH_2O ± 1.5 cmH_2O
Inspiratory pressure sensor	-10 to 100 cmH_2O ± 1.5 cmH_2O
Exhalation valve pressure sensor	-10 to 100 cmH_2O ± 1.5 cmH_2O
Barometric pressure sensor	600 to 1100 cmH_2O ± 10 cmH_2O
Turbine	50,000 rpm max flow range: 0 to 240 lpm
Oxygen valve	Inlet pressure: 7 psi Inlet flow: 15 lpm

3.4.1 Inlet Air Filter

The inlet air filter combines a fine particle filter with a foam backing. The filter traps particles at 3.3 microns with 99.999982% efficiency at 30 lpm flow.

3.4.2 Low Pressure Oxygen Inlet/valve

This female inlet connector includes an internal valve to prevent leakage when connecting and disconnecting an oxygen source. The maximum oxygen source pressure is approximately 7 psi (50 kPa) at 15 lpm flow. A special coupling is provided with the ventilator to connect the oxygen supply hose to the inlet connector.

3.4.3 Oxygen Solenoid Valve

The oxygen solenoid valve is a normally closed +24V DC two-way valve that is used to prevent oxygen from accumulating inside the ventilator. It opens when the ventilator is powered on and ventilating, and closes when the ventilator is in Standby or turned off. The CPU PCBA also commands this valve closed if there is an active DEVICE FAULT 6 (turbine overheat) alarm condition.

3.4.4 Inlet Silencer

Part of the turbine assembly, the inlet silencer reduces noise from the air inlet side of the turbine.

3.4.5 Turbine Assembly

The turbine is a low-inertia blower driven by a brushless DC motor that delivers gas by responding to pressure and flow measurements that are processed on the CPU PCBA. The turbine spins at a maximum of 50,000 rpm, and can deliver flows of up to 240 lpm and maximum pressures of 70 cmH_2O to 90 cmH_2O. A resistive-type temperature sensor resides in the turbine housing. The CPU monitors the temperature and will shut the turbine down if the temperature rises above 70° C while the turbine speed is less than 1000 rpm.

3.4.6 Outlet Silencer

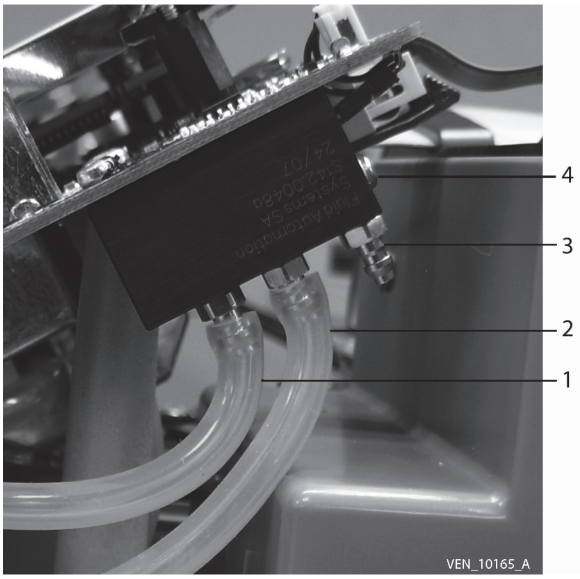
Part of the turbine assembly, the outlet silencer reduces noise from the outlet side of the turbine.

3.4.7 Exhalation Solenoid Valve

The exhalation solenoid valve is an electromagnetic, three-way proportional valve mounted on the CPU PCBA (Figure 3-1). It is used to control the pressure on the patient circuit exhalation valve diaphragm throughout the breathing cycle. Pressure supplied from a port at the turbine connects to solenoid valve port 1 (Figure A-3). Solenoid valve port 2 directs pressure through the exhalation valve port on the inspiratory block to the patient circuit exhalation valve diaphragm, where the pressure is used to completely or partially close the exhalation valve.

The voltage on the exhalation solenoid valve is under closed-loop control on a breath-to-breath basis using measurements from the inspiratory flow sensor. During inspiration, turbine gas flows from port 1 to 2 to apply pressure to the diaphragm to completely close the exhalation valve. At the beginning of exhalation, flow from the turbine is vented from port 2 to 3, relieving pressure on the exhalation valve diaphragm. This allows an initial purge flow and accompanying bias flow to flush the patient's exhaled gas from the patient circuit for the duration of exhalation (Figure A-3).During exhalation without PEEP, the flow path from port 2 to 3 is completely open allowing purge and bias flows. During exhalation with PEEP, flow is directed form port 1 to port 2 to apply a partial pressure to the patient circuit exhalation valve, while port 2 and port 3 are partially open simultaneously allowing purge and bias flows. The maximum bias flow does not exceed 40 lpm after a 15 breath-cycle stabilization period.

Figure 3-1. Exhalation Solenoid Valve



1	From turbine
2	To tee intersection with inspiratory block, exhalation valve port, and exhalation pressure transducer
3	To atmosphere
4	Exhalation solenoid valve

3.4.8 Inspiratory Block

The inspiratory block provides the means for inspiratory flow and pressure measurements. It includes a screen which creates a small pressure drop used to divert a portion of the inspired gas to the inspiratory flow sensor. This gas flows through a port on the upstream side of the screen, through the flow sensor, back into the gas stream through a port on the downstream side of the screen, then out the ventilator's To Patient port. Pressure ports for inspiratory, proximal, and exhalation pressure measurements are also located in the inspiratory block.

3.4.9 Inspiratory Flow Sensor

A mass air flow sensor located on the CPU PCBA measures inspiratory flow. A portion of the inspired flow is measured by the sensor which contains a heated sensing element and internal circuitry used to determine the flow rate. The CPU uses this flow measurement to control the turbine during volume ventilation, determine when an inspiratory flow trigger occurs (based on the inspiratory sensitivity setting), determine the beginning of exhalation (based on the expiratory sensitivity setting), and to calculate inspired tidal volume.

3.4.10 Proximal Pressure Sensor

The proximal pressure sensor, located on the CPU PCBA measures pressure at the patient wye via a tube that connects from the wye to the Proximal pressure port on the inspiratory block. This pressure measurement is used in the feedback loop to control the turbine speed during pressure ventilation modes.

3.4.11 Inspiratory Pressure Sensor

The inspiratory pressure sensor, located on the CPU PCBA, measures pressure of the gas as it exits the ventilator. The ventilator substitutes this pressure measurement for the proximal pressure measurement as a safety backup in the event that the proximal pressure tube becomes disconnected.

3.4.12 Exhalation Valve (Internal Valve) Pressure Sensor

The exhalation pressure sensor, located on the CPU PCBA, is used as a safety feature to detect the presence and proper operation of the patient circuit exhalation valve. The exhalation valve port on the inspiratory block provides the pathway for the pressure measurement.

3.4.13 Exhalation Block

On the Puritan Bennett 560 Ventilator (when using a dual limb patient circuit), the exhalation block provides the means to measure exhaled flow. A pressure drop is created as exhaled gas passes through an orifice in the exhalation block. Pressure taps, located on either side of the orifice, provide the connections to the exhalation flow sensor on the CPU PCBA. The measured flow is used to calculate exhaled tidal volume.

3.4.14 Exhalation Flow Sensor

The exhalation flow sensor is a mass air flow sensor that measures exhalation flow upstream of an orifice in the exhalation block. A portion of the exhalation flow is diverted through the sensor which contains a heated sensing element that converts the mass of air flowing past the element into a voltage. The flow is returned to the exhalation block after it passes through the exhalation flow sensor. The CPU uses the flow measurement to calculate exhaled tidal volume.

3.4.15 Barometric Pressure Sensor

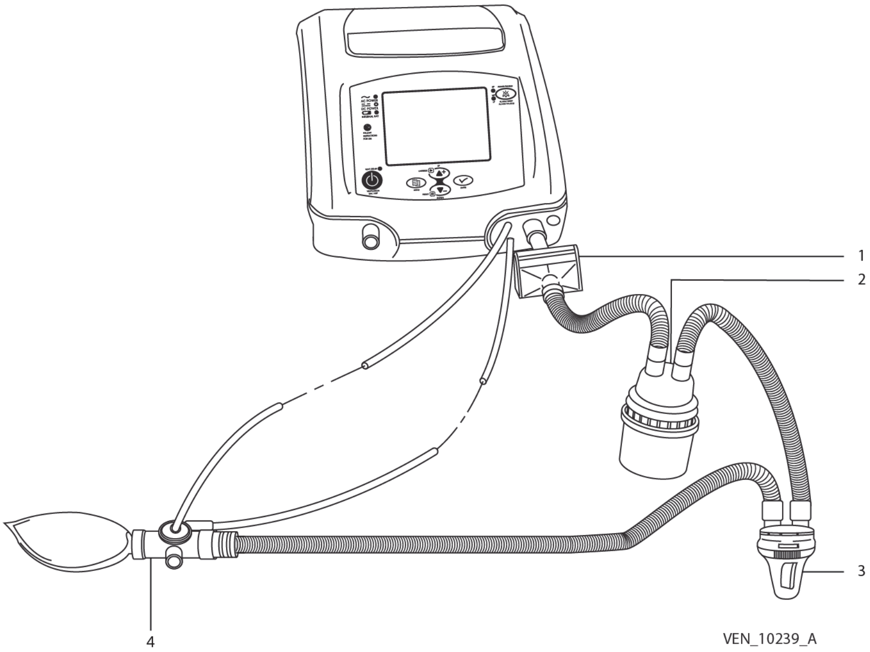
The barometric pressure sensor is used to correct flow measurements when the device's Altitude Compensation feature is enabled. Covidien recommends that Altitude Compensation always be set to YES in the Measurements Check screen of Maintenance Mode.

3.4.16 Patient Circuit

The Puritan Bennett 560 Ventilator can be used with a single- or double-limb patient circuit. Both circuits use an exhalation valve to allow ventilation with a set PEEP level. The double-limb circuit allows for exhaled tidal volume measurements by routing exhaled gas through the exhalation block. A special patient circuit having only an inspiratory limb with a proximal pressure line connected and no exhalation valve must be used when NIV ventilation in CPAP or pressure support mode is selected.

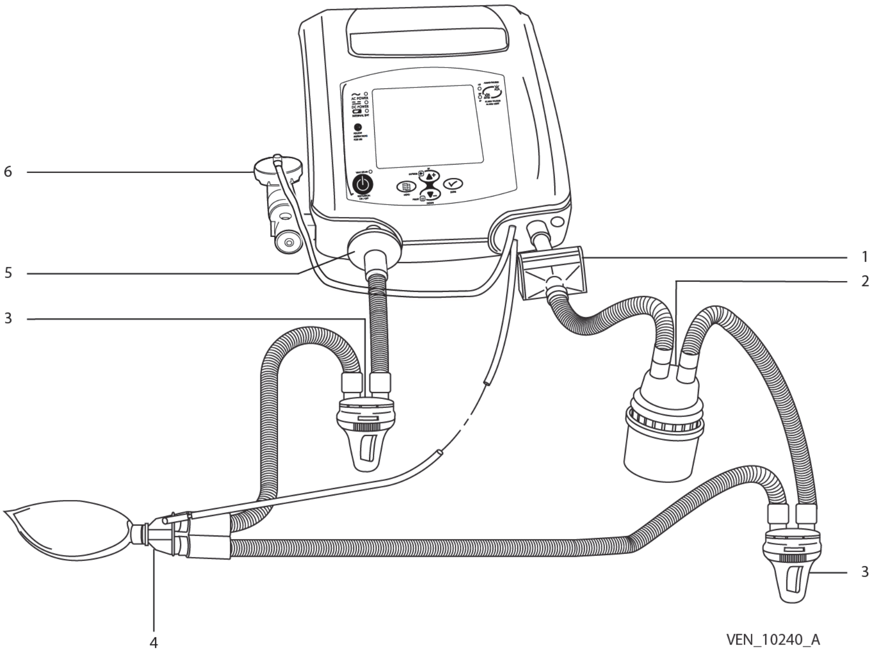
A humidifier and water traps can be used with either circuit as shown in Figure 3-2 and Figure 3-3. The patient must wear a vented NIV interface if a single-limb circuit without an exhalation valve is used.

Figure 3-2. Ventilator with Single-Limb Circuit and Test Lung



1	Inspiratory bacteria filter	3	Water trap
2	Humidifier	4	Single limb patient circuit with exhalation valve

Figure 3-3. Ventilator with Dual-Limb Patient Circuit and Test Lung



1 Inspiratory bacteria filter	**4** Dual limb patient circuit
2 Humidifier	**5** Exhalation bacteria filter
3 Water traps	**6** Exhalation valve at outlet of exhalation block

3.5 Electrical System

This section describes the components of the electrical system and their functions.

3.5.1 Power Management PCBA

The Power Management PCBA performs the following functions in the Puritan Bennett 560 Ventilator:

- converts AC voltage to DC voltage
- converts, regulates, and distributes DC voltages
- manages internal battery charging and discharging
- automatically adapts battery management to the battery capacity identified
- prioritizes the use of AC, external DC and internal battery power sources
- provides USB mini type B interface for Covidien service personnel to upload application software to the ventilator
- provides two Type A USB connectors used for obtaining trended information which can be transferred to a PC
- acquires and responds to voltage, current, and temperature measurements via a microcontroller.

Figure A-2 shows a block diagram of the Power Management PCBA.

3.5.2 AC to DC Conversion

AC power enters the Power Management PCBA through the mains connector with nominal input voltage and frequency ranges of 90 to 250 V AC and 50 to 60 Hz, respectively. The AC power is converted to 33 V DC (nominal) and supplies up to 3 A current.

3.5.3 DC Voltage Conversion and Distribution

If AC power is unavailable, the ventilator may be connected through the DC input connector on the Power Management PCBA to an external DC power source (12 to 30 V DC), such as an automobile power port, or will obtain its power directly from the internal battery (26 V, nominal). Whether the DC voltage is supplied from AC, external DC, or internal battery, it is converted to four regulated voltages:

- 24 V — Used to supply the turbine and fan directly from the Power Management PCBA, and distributed to the CPU PCBA. The Power Management PCBA monitors this voltage to ensure it remains within the range of 22 V to 26 V. The current output is limited to 4 A.
- 5 V — Used by the Power Management PCBA electronics and distributed to the CPU PCBA for event memory. The Power Management PCBA monitors this voltage to ensure it remains within the range of 4.5 to 5.5 V. The current output is limited to 1 A.
- 3.3 V — Used for RAM voltage supply and distributed to the CPU PCBA for monitored parameter memory. The Power Management PCBA monitors this voltage to ensure it remains within the range of 3.0 to 3.6 V. The output current is limited to 500 mA.
- 3 V ref — Reference for voltage measurements.

3.5.4 Internal Battery Charging and Discharging

The Power Management PCBA manages internal battery charging and discharging using a combination of voltage, current, and temperature measurements, and charging time. Additional protections are in place to prohibit battery charging if charging current and voltage out-of-bounds conditions are detected.

Battery charging occurs in two phases, and only when the ventilator is connected to an AC power source and when battery voltage drops below 28.5 V. In the first phase, the battery is charged using 500 mA (when ventilator is operating) or 1.5 A (when ventilator is not operating) until the battery reaches 29.4 V ± 1%. The second phase maintains this voltage and monitors the current. When the current drops to below 150 mA, the charging circuit turns off. When the battery discharges to 28.5 V, the charging cycle starts again.

Over-charge voltage protection ensures that battery charging is canceled if battery voltage exceeds approximately 30 V. Over-discharge voltage protection prevents the battery from discharging below approximately 14 V. Battery usage is not allowed until the battery is charged to greater than approximately 19 V.

Battery temperature also affects the ability of the battery to charge and discharge. Software controls are in place to discontinue battery charging if the battery temperature is greater than 45° C or less than 0° C. Software also prevents the battery from being used as the power source if the battery temperature is greater than 60° C or less than -10° C.

Software estimates the battery capacity (mAh) delivered during charging and compares it to a maximum threshold value. If the estimated capacity is greater than the maximum value, the software determines that the charging time is too long, and a new battery charge cycle is not allowed.

Battery discharging cycles are calculated every 5% of battery discharge, and are a function of the battery capacity at the start of a discharge, the remaining battery capacity, and the number of previous discharges (including partial discharges). The number of discharging cycles can be read from the Internal Battery Menu with the ventilator in Maintenance mode. The battery should be replaced when battery capacity is less than 3840 mAh.

3.5.5 Power Source Priority and Switching

The Puritan Bennett 560 Ventilator can operate using Mains AC, DC power supplied by an external DC power source (e.g., automobile power port), or DC power supplied by an internal battery. The Power Management PCBA drives the LEDs on the ventilator's control panel that indicate which power source is in use.

When the ventilator is running using an external DC power source, the battery charging circuit does not function. When the ventilator is connected to more than one power source, the Power Management PCBA ensures that the resultant power source is available according to the priority shown in Table 3-2. In the table, presence means that there is at least the minimum power requirement available from the indicated source.

During ventilator operation, if AC mains power is lost, the ventilator will automatically switch to external DC power, if available, or internal battery. When the ventilator is running on internal battery, an audible signal is annunciated every hour as a reminder that the ventilator is running on battery power. A battery "fuel gauge" appears on the LCD panel letting you know the approximate capacity left in% or time units.

Table 3-2. Power Source Switching Priority

AC present	External DC power source present	Internal battery present	Resultant power source used for ventilator operation
✓	✓	✓	AC
–	✓	✓	External DC power source
–	–	✓	Internal battery
✓	–	✓	AC
✓	–	–	AC
✓	✓	–	AC
–	✓	–	External DC power source
–	–	–	No ventilation

3.5.6 USB Interface

Two Type A and one mini B USB ports are provided on the Power Management PCBA. The type A ports are used for obtaining trended, event, and monitoring information. Only one USB port may be used at a time, or an alarm message will annunciate. Up to 12 months of trended ventilator data may be stored on a USB key (128 MB minimum memory and 32-bit file format required). This information may be transferred to a PC. The mini B port is used for performance verification with the Puritan Bennett™ 500 Series Ventilator Test Software and for uploading application software to the ventilator. The mini B port is used as a communication interface between a PC and the Power Management PCBA. A 115 K Baud rate is supported.

WARNING

Always verify that the serial number of the ventilator is correctly associated with the correct patient before using a USB memory device to transfer data between the ventilator and a PC.

3.5.7 Microcontroller Functions

A PIC microcontroller on the Power Management PCBA processes data from the battery's memory and temperature sensor, the internal ventilator temperature sensor (CT1), and voltage regulators. These data are communicated to the CPU PCBA via a Serial Peripheral Interface (SPI) bus and are monitored to determine the state of the ventilator.

The microcontroller reads the internal ventilator temperature sensor and the battery temperature sensor and uses these readings to control the speed of the cooling fan, which maintains proper internal operating temperatures for the electronics.

During events such as ventilator operating software uploads or ventilator event log downloads, the Power Management PCBA microcontroller transmits PC communication data (at a 256 K Baud rate) to the CPU PCBA.

At ventilator startup, during POST, the Power Management PCBA is responsible for temporarily disabling alarms. If an error is detected, the three power source LEDs flash, alarm functions are restored and a Very High Priority alarm sounds. The ventilator is prevented from entering Standby mode and ventilation is disallowed.

3.5.8 CPU PCBA

The CPU PCBA performs the following functions:

- controls breath delivery functions of the ventilator
- displays information to the user through the LCD panel
- communicates with the Power Management PCBA
- provides continuous status and monitoring for errors
- stores ventilator settings, patient data, and events in memory
- interfaces with external devices.

3.5.9 Breath Delivery Functions

Software running in the microcontroller on the CPU PCBA processes ventilator and alarm setting inputs from the keyboard. A turbine interface circuit uses the ventilator settings to generate a pulse-width-modulated (PWM) signal that controls the turbine speed appropriately for inspiration and exhalation. The microcontroller detects an inspiratory trigger when a combination of the current and previous inspiratory flow sensor measurements are greater than the inspiratory sensitivity setting in all modes except for CPAP, in which case the inspiratory flow readings are compared with an average flow. Exhalation occurs after the rise time has elapsed and when inspiratory flow has decreased from peak flow to a predetermined percentage of peak flow (or the set expiratory sensitivity in PSV ST). Signals from the on-board flow transducers provide feedback upon which the turbine adjusts its speed to maintain the set volume or pressure and PEEP level.

A PWM signal drives the exhalation solenoid valve on the PCBA that controls the patient circuit exhalation valve. The voltage to the exhalation solenoid valve varies depending upon whether the breath cycle is in the inspiratory or exhalation phase. During the inspiratory phase, 24 V is applied to the valve which allows all flow to pass from port 1 through port 2, keeping the patient circuit exhalation valve closed. During exhalation, the voltage is modulated to allow flow through ports 2 and 3 (if no PEEP is set), or simultaneously through ports 2 and 3 and ports 1 and 2 (if PEEP is set). (See Figure A-3.)

During ventilation, a PWM signal opens a 2-way solenoid valve to allow the use of supplemental oxygen. The valve remains open as long as the device is in ventilation mode. It closes when the ventilator is turned off or in standby mode, or during a TURBINE OVERLOAD alarm condition which can occur if there is a combination of high turbine temperature and low turbine speed.

3.5.10 LCD Panel Interface

The LCD panel connects to the CPU PCBA through a parallel bus and provides a visual display of ventilator and alarm settings, breath waveforms, and service information.

3.5.11 Power Management PCBA Communication

Communication between the CPU PCBA and the Power Management PCBA occurs through an SPI bus. The CPU PCBA receives AC, DC, and battery supply voltage status from the Power Management microcontroller and relays this information to the keyboard power LED indicators.

A UART bus enables communication between the CPU and a PC through the Power Management PCBA. A 115.2 kBaud data transfer rate for event log downloads is supported, while software updates can occur at up to 256 kBaud. An analog signal is supplied by the Power Management PCBA for transmitting the battery voltage to the CPU PCBA.

3.5.12 Status and Error Monitoring

The CPU PCBA continuously monitors signals and voltages to determine the status of the ventilator. A watchdog circuit detects proper execution of processor instructions by receiving a pulse from the microcontroller at specified time intervals. If the watchdog does not receive the pulse at the appropriate time, a reset signal is generated, after which POST runs. If POST passes, ventilation continues as previously set. During POST, the ventilator is in its safe state, with turbine stopped and exhalation valve open. If POST fails, a Very High Priority alarm occurs and ventilation is not allowed.

Reference voltage monitors on the CPU PCBA detect the status of 5 V, and 10 V reference voltages. If a drop in either of these voltages beyond 0.5 V, or 1.1 V, respectively, occurs, a digital signal is generated and an alarm is annunciated. A monitor for the 3.3 V supply voltage will generate a digital signal and alarm if a drop of greater than 0.3 V is detected.

3.5.13 Memory

There are four types of memory on the CPU PCBA: ventilator settings memory, event memory, monitoring memory, and random access memory (RAM).

Ventilator parameter and alarm settings are stored in a minimum of 4 kB of non-volatile memory to ensure settings are retained when the ventilator’s power is turned off or during a loss-of-power condition.

A minimum of 512 kB of non-volatile event memory stores the event log. This log records information such as ventilator stops and starts, confirmed ventilator and alarm settings, and alarm and technical fault history including any associated audio paused or alarm paused key-presses, alarm resets, and acknowledgment key presses. This information is also retained when the ventilator is turned off and during power losses.

A minimum of 128 MB of non-volatile monitoring memory capacity is available for recording monitored patient data. These data are linked to the time of occurrence of associated events. A minimum of 64 KB of RAM is available for storage of operating software program variables. The data stored in RAM are not saved during periods when the ventilator is turned off.

3.5.14 Turbine Control PCBA

The Turbine Control PCBA controls turbine speed and braking and transmits turbine speed and temperature feedback signals to the CPU PCBA. The Turbine Control PCBA also monitors the current in the turbine motor windings and the position of the motor via a position sensor input signal from the motor. In the event of a turbine malfunction, fault detection signals are generated from the Turbine Control PCBA and transmitted to the CPU PCBA. A 24 V input from the CPU PCBA to the Turbine Control PCBA produces a 15 V output to drive the motor controller logic devices.

3.5.15 Buzzer PCBA

Two alarm buzzers are located on the buzzer PCBA. The buzzer PCBA is capable of producing 65 - 80 dBA alarm tones based on the alarm priority. A 4.8 V Ni-MH battery is mounted on the buzzer PCBA to power the ventilator’s POWER SUPPLY LOSS alarm. The battery is charged to a maximum voltage of 5.6 V. At this point the charger switches to a trickle-charge mode which maintains the battery voltage.

3.5.16 Battery Connection PCBA

The Battery Connection PCBA provides the physical connection between the battery and the Power Management PCBA. A connector with spring-loaded “fingers” on this PCBA touches the battery contacts providing DC power to the Power Management PCBA and allowing the battery temperature and memory to be read.

3.5.17 Internal Battery

The rechargeable internal battery is a 14-cell lithium-ion battery that includes a temperature sensor and a memory device which stores information, such as battery identification, capacity, number of discharge cycles, manufacture date and time and battery cell type. The ventilator displays this information in the Internal Battery menu, accessible through Maintenance mode and Measurement Check. The battery identification information is checked by the Power Management PCBA and if the stored information is incorrect, or if the data are corrupt, a BATT FAULT 3 alarm will occur.

3.5.18 Ventilator Compartment Temperature Sensor

This sensor, located on the Power Management PCBA, measures the air temperature inside the ventilator. The temperature signal is used to control the speed of the fan in the ventilator compartment.

3.5.19 Fan

A fan, located in the main ventilator compartment and controlled via the Power Management PCBA, produces air flow through the ventilator and battery compartments to cool the electronics and to expel any oxygen vented through the exhalation solenoid valve to the outside of the ventilator.Room air enters the ventilator through the vents in the battery cover at the rear of the device and exits through the cooling vents in the front and sides where the upper and lower housings meet (see Figure 2-2 and Figure 2-6).

The fan runs continuously when the ventilator is connected to AC power regardless of whether the ventilator is powered off, powered on but in Standby mode, or ventilating. If the external or internal battery is used, the fan runs any time the power switch is turned on. The fan’s speed adjusts to maintain an internal ventilator temperature of no greater than 60° C (measured on the Power Management PCBA), and a battery temperature of no greater than 40° C. Additionally, the fan will run at maximum speed if the internal ventilator temperature sensor should fail.

3.6 Ventilation Features

3.6.1 Vt target

The Puritan Bennett 560 Ventilator has the Vt target (Target Volume) feature as a part of pressure-based ventilation modes in non-invasive ventilation without an exhalation valve. This allows a range of pressures to be used to reach a set volume. If the mode is PSV ST or P A/C, you may select Vt Target within the range of 50 to 2000 mL (or OFF) which controls the inspired tidal volume to the target value you specify. An increasing or decreasing series of small pressure adjustments are applied and the inspired volume is measured. If the inspired volume is lower than the target volume, the pressure of the next breath increases a small amount and the inspired volume is measured again. If the inspired volume is higher than the target volume, the pressure of the next breath is decreased slightly, until the inspired volume matches the target volume. The pressure increases stop if the maximum inspiratory pressure is reached.

3.6.2 Leak Compensation

Leak compensation is available on the Puritan Bennett 560 Ventilator in pressure-based ventilation modes. Leak compensation is used with non-invasive ventilation with a vented mask. It is normal for vented masks to have a known leak associated with them.The leak from the mask is estimated at the end of exhalation and this leak is taken into account in the patient’s inspired volume measurements.

3.6.3 Circuit Detection and Management

The Puritan Bennett 560 Ventilator can check the configuration of the patient circuit and high priority alarms will sound when the ventilator settings are incompatible with the circuit used. Some examples are:

- inspiratory pressure greater than 30 without an exhalation valve in the patient circuit

- exhalation pressure less than 4 without an exhalation valve in the patient circuit
- using CPAP mode with an exhalation valve in the patient circuit
- using volume ventilation without an exhalation valve in the patient circuit
- inspiratory or exhalation pressure difference less than 5 without a valve in the patient circuit.

These alarms will sound if a mode change is made that violates any of the aforementioned conditions. Upon detection of the incompatible circuit, the ventilator will not start ventilation, but will immediately detect when the circuit has been changed.

3.6.4 Relative or Absolute Pressure

You can determine how you want to view pressure settings — in the relative or absolute mode. For example, if you configure the ventilator for relative mode, and pressure support or pressure control is set to 10 cmH_2O and PEEP is set to 5 cmH_2O then the inspiratory pressure delivered will read 15 cmH_2O. If absolute pressure is selected with the same settings, the inspiratory pressure is 10 cmH_2O. This also applies to P Max in target Vt. The pressure convention is selected in the SETUP menu. Refer to Section 2.12 to open the SETUP menu and configure the ventilator for the desired pressure display. Relative or absolute pressure is different than the pressure units the ventilator uses for displayed pressure. The pressure units can be selected in the SETUP menu with cmH_2O, hPa, or mbar available. Peak Inspiratory pressure and End Inspiratory Pressure are calculated as follows:

Peak Inspiratory Pressure during pressure rise shall not be more than (P SUPPORT or Pi + PEEP) if Relative pressure is YES or (P SUPPORT or Pi) if Relative pressure is OFF.

End inspiratory pressure shall be within the setting (P SUPPORT or Pi + PEEP) ± 1 cmH_2O + 10%) if Relative pressure is YES or (P SUPPORT or Pi) ± 1 cmH_2O + 10%) if Relative pressure is OFF. The pressure overshoot during the pressure fall phase shall not be less than PEEP x 0.8 - 1 cmH_2O.

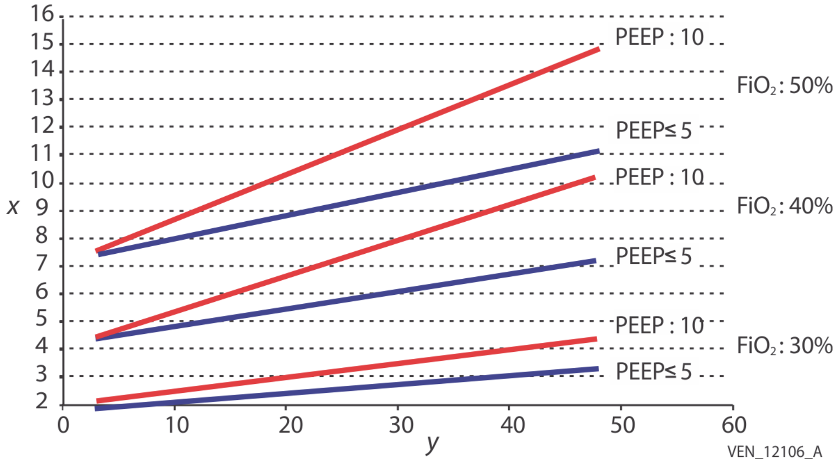
3.6.5 Invasive or Non-invasive Ventilation

The ventilator can be used invasively or non-invasively. If used invasively, the ventilator is said to be used in valve configuration. Valve configuration means that the ventilator has an exhalation valve attached to the ventilator at the exhalation port.The inspiratory volume should be greater than or equal to 150 mL with no leak present. If used non-invasively, leak configuration means that there is no exhalation valve used — there is a known leak in the patient system.

3.6.6 FiO_2 for Various Oxygen and Ventilator Settings

Figure 3-4 contains a chart showing the relationship between oxygen flow and inhaled flow for various oxygen concentrations and PEEP settings for the Puritan Bennett 560 Ventilator.

Figure 3-4. FiO_2 for various Oxygen and Ventilator Settings



x O_2 flow (l/min)

y Inhalation flow (l/min)

Note: Tests conducted in a valve configuration. Results can vary according to whether the circuit is configured with or without a valve and patient lung characteristics.

WARNING

The Puritan Bennett 560 Ventilator can be used with an oxygen analyzer with minimum and maximum concentration alarms. Always measure the delivered oxygen with a calibrated oxygen analyzer that features a minimum and maximum concentration alarm in order to ensure that the prescribed oxygen concentration is delivered to the patient.

4 Alarms and Troubleshooting

This chapter provides information on how to view and respond to alarms and technical faults and suggests ways to troubleshoot the Puritan Bennett™ 560 Ventilator

The ventilator responds to fault conditions with two types of alarms:

- technical faults
- ventilation alarms.

Technical faults indicate conditions that do not immediately affect ventilator operation, but need correcting to restore proper ventilator function. Technical faults do not produce audible alarms but are recorded in the ventilator's Technical Fault log which is accessed through the Faults Check menu in Maintenance mode. A service technician is required to correct technical faults.

Ventilation alarms are those that audibly and visually alert the user to degraded patient conditions or a ventilator malfunction and require immediate attention. When this type of alarm occurs, a message appears on the LCD panel and is recorded in the ventilator's alarm log. Many ventilation alarm limits are adjustable and are set after entering the patient's ventilation parameters. (Refer to the Alarm settings section of Table 2-4 for a list of adjustable alarms.) Other ventilation alarms, such as AC power disconnection and low battery cannot be adjusted. Most ventilation alarm conditions can be responded to and corrected by the clinician or caregiver. In some cases, however, ventilation alarms can indicate problems with the ventilator hardware or patient circuit. See Section 4.4.2 for information on troubleshooting these types of ventilation alarms.

4.1 Alarm Classification

Alarms are classified according to how their causes affect ventilator operation. Table 4-1 lists alarm classifications and associated ventilator responses.

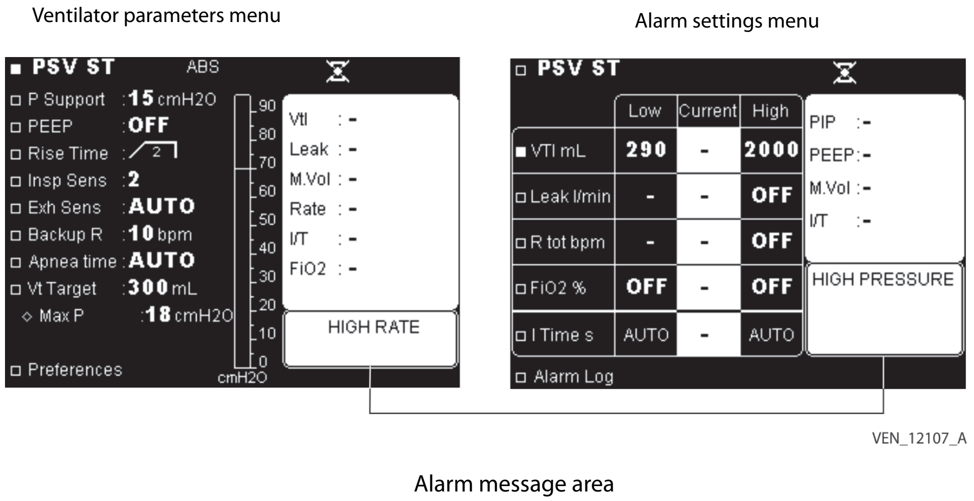
Table 4-1. Alarm Priority Classification

Classification	Effect on ventilation and ventilator response
Very High Priority (VHP)	No ventilation. Depending upon the cause, the ventilator always generates a continuous audible alarm at maximum volume and the following indicators may or may not be displayed: • red continuously lit LED • alarm message displayed on ventilator screen • illuminated backlight.
High Priority (HP)	Compromised ventilation. Ventilator responds with: • a repeating series of 3 beeps then 2 beeps at the user-selected volume • red flashing LED illumination • alarm message • illuminated backlight. **Note:** If the cause of an alarm is not corrected, and if the Alarm Control key is not pressed within 60 seconds of an alarm trigger, high priority alarms will sound at the maximum volume.
Medium Priority	Ventilation not immediately affected, but could harm patient if left uncorrected. Ventilator responds with: • a repeating series of 3 beeps at the user-selected volume • yellow flashing LED illumination • alarm message • illuminated backlight.
Low Priority	There are currently no Low Priority alarms

4.2 How to Respond to Alarms

When an alarm condition is detected, visual and audible indicators occur according to the alarm classification described in Table 4-1. The alarm display message appears only on the ventilator parameters or alarm settings menus. If the waveforms screen is being viewed when an alarm occurs, the display will switch to either the ventilator parameters or alarm settings menu (Figure 4-1).

Figure 4-1. Alarm Display Messages



■ PSV ST ABS

☐ P Support : 15 cmH2O
☐ PEEP : OFF
☐ Rise Time : 2
☐ Insp Sens : 2
☐ Exh Sens : AUTO
☐ Backup R : 10 bpm
☐ Apnea time : AUTO
☐ Vt Target : 300 mL
◇ Max P : 18 cmH2O
☐ Preferences

Vtl : -
Leak : -
M.Vol : -
Rate : -
I/T : -
FiO2 : -

☐ PSV ST

	Low	Current	High
■ VTI mL	290	-	2000
☐ Leak l/min	-	-	OFF
☐ R tot bpm	-	-	OFF
☐ FiO2 %	OFF	-	OFF
☐ I Time s	AUTO	-	AUTO

☐ Alarm Log

PIP : -
PEEP : -
M.Vol : -
I/T : -

If multiple alarms occur at the same time, the LED indicator and alarm sound of the highest priority alarm takes effect, but messages for all active alarms scroll in succession.

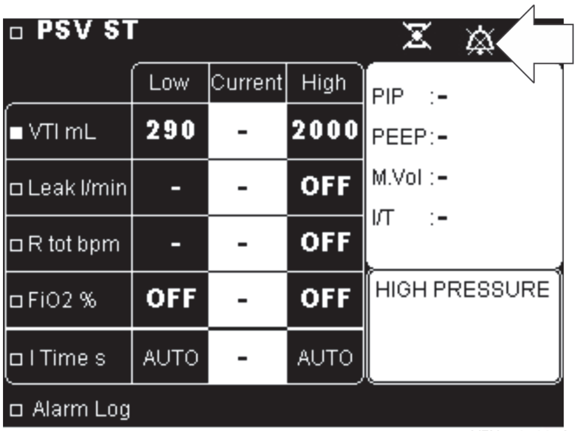
4.2.1 How to Pause the Audible Portion of an Alarm

To pause the audible portion of an alarm (audio paused):

Press the **ALARM CONTROL** key once.

This pauses the audio portion of the alarm for all active alarms for up to 60 seconds and displays the Audio Paused symbol on the screen (Figure 4-2). The **ALARM CONTROL** key also pauses the audible portion of a remote alarm (nurse call) for 60 seconds if connected. Alarm messages and LED indicators remain active during this 60-second period. The Audio Paused period expires after 60 seconds or immediately, when a new alarm condition is detected.

Figure 4-2. Alarm Settings Menu During Audio Paused Period



☐ PSV ST

	Low	Current	High
■ VTI mL	290	-	2000
☐ Leak l/min	-	-	OFF
☐ R tot bpm	-	-	OFF
☐ FiO2 %	OFF	-	OFF
☐ I Time s	AUTO	-	AUTO

PIP :-
PEEP:-
M.Vol :-
I/T :-

HIGH PRESSURE

☐ Alarm Log

VEN_10198_A

Audio paused symbol

4.2.2 How to Pause an Alarm

Most alarms are automatically cleared as soon as the conditions causing them no longer exist. The exceptions are the Apnea alarm, which clears after two patient breaths, and the High Pressure alarm, whose LED indicator and alarm message remain active after the high pressure condition is corrected.

Some alarms, however, can be paused manually even if the cause of their activation remains (these alarms are identified in Table 4-3.)

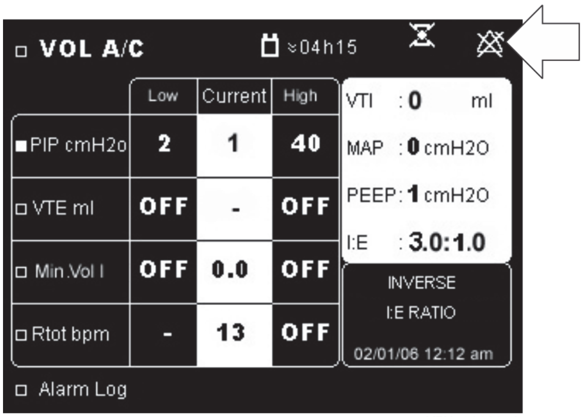
To manually pause an alarm (alarm paused):

Press the **ALARM CONTROL** key twice.

The alarm sound and LED indicator are suspended and the Alarm Paused symbol appears at the top right of the Ventilator Parameters, Alarm Settings, and Waveforms screens (Figure 4-3). The alarm message disappears from the Ventilator Parameters screen.

When no other alarms are currently active, the last alarm paused appears continuously in the alarm message window in the Alarms Settings menu, along with the date and time of its activation.

Figure 4-3. Alarm Settings Menu During Alarm Paused Condition



☐ VOL A/C ≈04h15

	Low	Current	High
■ PIP cmH2o	2	1	40
☐ VTE ml	OFF	-	OFF
☐ Min.Vol l	OFF	0.0	OFF
☐ Rtot bpm	-	13	OFF

VTI : 0 ml
MAP : 0 cmH2O
PEEP: 1 cmH2O
I:E : 3.0:1.0

INVERSE
I:E RATIO
02/01/06 12:12 am

☐ Alarm Log

VEN_10199_A

Alarm paused symbol

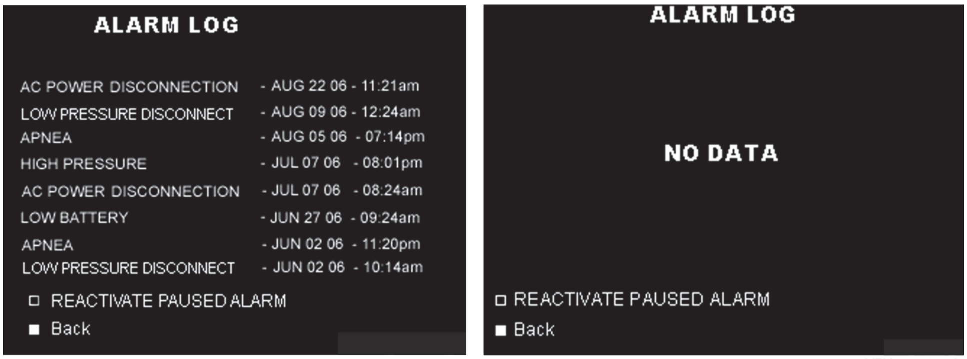
4.2.3 How to Reactivate a Paused Alarm

Alarms whose causes continue to exist can be reactivated so that audible and visual indicators are restored.

To reactivate a paused alarm:

1. If not currently displayed, press **MENU** to access the Alarm Settings menu.
2. Press the **UP** or **DOWN** arrow key to place the cursor at the “Alarm Log” position.
3. Press **ENTER**, to confirm your selection. The alarm log screen appears (Figure 4-4).

Figure 4-4. Alarm Log Screen With and Without Alarms



ALARM LOG

AC POWER DISCONNECTION - AUG 22 06 - 11:21am
LOW PRESSURE DISCONNECT - AUG 09 06 - 12:24am
APNEA - AUG 05 06 - 07:14pm
HIGH PRESSURE - JUL 07 06 - 08:01pm
AC POWER DISCONNECTION - JUL 07 06 - 08:24am
LOW BATTERY - JUN 27 06 - 09:24am
APNEA - JUN 02 06 - 11:20pm
LOW PRESSURE DISCONNECT - JUN 02 06 - 10:14am

☐ REACTIVATE PAUSED ALARM
■ Back

ALARM LOG

NO DATA

☐ REACTIVATE PAUSED ALARM
■ Back

VEN_12108_A

4. Press the **UP** arrow key to place the cursor at the "REACTIVATE PAUSED ALARM" position.
5. Press and hold **ENTER** for at least three (3) seconds. The following events occur:
   - a beep tone sounds
   - the alarm sounds
   - the alarm LED indicator flashes
   - the messages of all active alarms are displayed in succession in the Ventilation Parameters and Alarm Settings menus
   - the Audio Paused symbol disappears (if it was displayed)
   - the Alarm Paused symbol disappears.
6. Exit the alarm log screen by pressing the down arrow key to place the cursor at the "Back" position.
7. Press **ENTER** to confirm your selection. The display returns to the Alarms Settings menu.

4.2.4 Alarm Reset Function

The Alarm Reset function applies only to the High Pressure alarm. A High Pressure alarm occurs when the inspiratory pressure exceeds the high pressure alarm threshold set in the Alarm Settings menu.

During a high pressure condition, the audible High Priority alarm sounds, the red LED flashes, and an alarm message displays on the screen, flashing in inverse video. If the high pressure condition corrects itself, the audio portion of the alarm resets (becomes silent), but the red LED and the alarm message remain flashing.

To manually reset the High Pressure alarm, which turns off the illuminated LED and clears the flashing alarm message, press the **ALARM CONTROL** key twice.

4.3 How to Access Stored Ventilator Diagnostic Logs

The Puritan Bennett 560 Ventilator stores information about its performance that can be used to troubleshoot and correct ventilator malfunctions. The Alarm, Technical Fault, and Event logs provide this information.

The Alarm and Technical Fault logs are viewed directly from the ventilator screen. Additionally, the Event log can be downloaded to a PC. Contact your Covidien service representative for more information.

The Alarm, Technical Fault, and Event logs are stored in non-volatile memory on the CPU PCBA, ensuring that the information is retained when the ventilator is powered off and during power loss conditions.

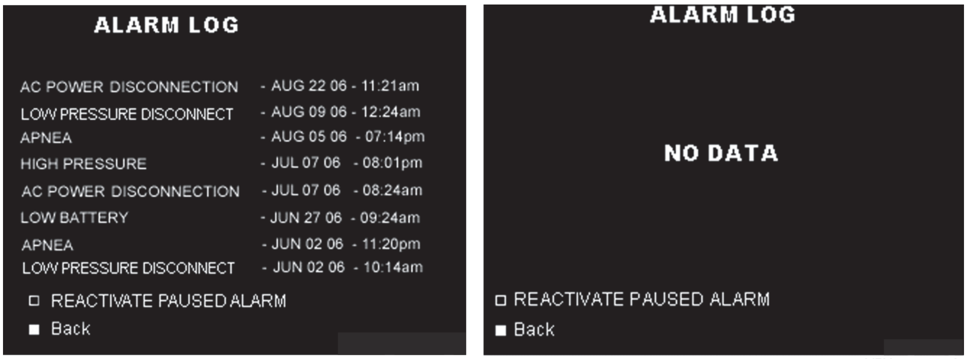
4.3.1 Alarm Log

The Alarm log can be viewed from the ventilator screen when the ventilator is in standby mode or ventilation mode. This log displays up to eight (8) of the most recent ventilation alarms, including the date and time of occurrence ().

To view the Alarm Log screen:

1. Follow steps 1-3 of Section 4.2.3. The alarms appearing in the log are described in Table 4-3.

Figure 4-5. Alarm Log Screen With and Without Alarm Information



```
ALARM LOG

AC POWER DISCONNECTION      - AUG 22 06 - 11:21am
LOW PRESSURE DISCONNECT     - AUG 09 06 - 12:24am
APNEA                       - AUG 05 06 - 07:14pm
HIGH PRESSURE               - JUL 07 06 - 08:01pm
AC POWER DISCONNECTION      - JUL 07 06 - 08:24am
LOW BATTERY                 - JUN 27 06 - 09:24am
APNEA                       - JUN 02 06 - 11:20pm
LOW PRESSURE DISCONNECT     - JUN 02 06 - 10:14am
☐ REACTIVATE PAUSED ALARM
■ Back
```

```
ALARM LOG

NO DATA

☐ REACTIVATE PAUSED ALARM
■ Back
```

VEN_12108_A

To exit the Alarm Log screen, use the **UP** or **DOWN** arrow key to place the cursor at the “Back” position and press **ENTER**. The Alarm Log screen is dismissed automatically when a new alarm occurs, or after 15 seconds if no key is pressed.

4.3.2 Technical Fault Log

The Technical Fault log can be viewed when the ventilator is in Maintenance mode, and displays up to nine (9) of the most recent technical faults including date and time of occurrence, and machine hours. A list of technical faults is provided in Table 4-2.

If the software lock is enabled (a key symbol 🔑 appears in the upper left corner of ventilator screen), you must disable it before you can view the technical fault log.

To unlock the ventilator software:

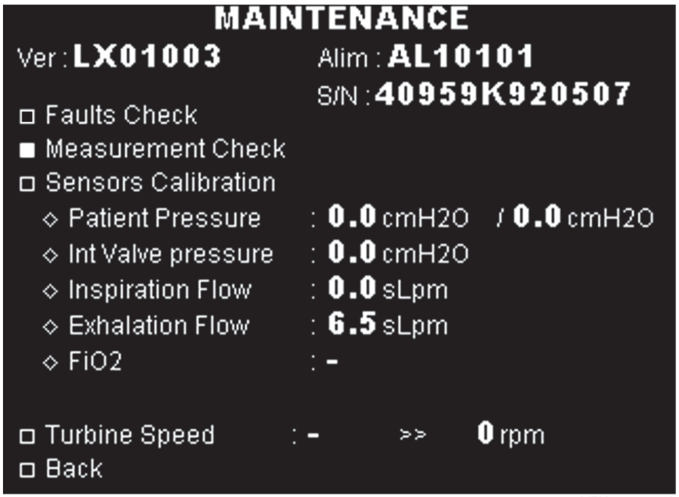
1. Simultaneously press and hold the **UP** or **DOWN** arrow keys for 3 seconds. The key symbol in the upper left corner of the display disappears, indicating that the software is unlocked.

To enter Maintenance mode and view the technical fault log:

1. If the ventilator is ventilating, stop ventilation via the Ventilation ON/OFF key prior to turning the ventilator power switch OFF.
2. Press and hold the **ALARM CONTROL** key while simultaneously switching the ventilator to the ON position. Continue holding the key until the Setup screen appears.
3. Use the **UP** or **DOWN** key to place the cursor at the Maintenance position.
4. Press **ENTER**. The maintenance screen appears (Figure 4-6).

   The Maintenance screen displays the CPU and Power management CPU software versions, number of ventilator hours, serial number, and a menu of checks and calibrations designed to troubleshoot and verify the performance of the ventilator.

Figure 4-6. Maintenance Screen



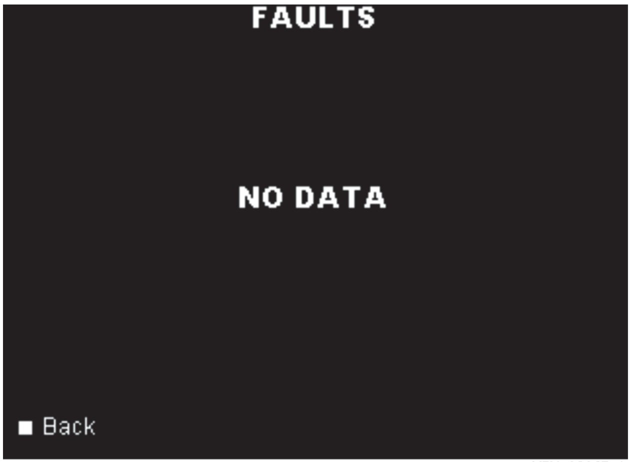
```
                    MAINTENANCE
Ver : LX01003               Alim : AL10101
                            S/N : 40959K920507
☐ Faults Check
■ Measurement Check
☐ Sensors Calibration
   ◇ Patient Pressure     : 0.0 cmH2O   / 0.0 cmH2O
   ◇ Int Valve pressure   : 0.0 cmH2O
   ◇ Inspiration Flow     : 0.0 sLpm
   ◇ Exhalation Flow      : 6.5 sLpm
   ◇ FiO2                 : -

☐ Turbine Speed          : -       >>      0 rpm
☐ Back
```

VEN_11213_A

5. After entering Maintenance mode, the cursor's default position is Faults Check. Press **ENTER** to view the list of technical faults (Figure 4-7). If there are no technical faults in memory, the message "NO DATA" appears on the screen.

Figure 4-7. Faults Screen With no Faults Present



FAULTS

NO DATA

VEN_10167_A

4.3.3 Event Log

An event log, capable of storing up to 5000 entries, is maintained in the ventilator's non-volatile memory. After 5000 entries are stored in the event log, the ventilator overwrites the data using a first-in-first-out (FIFO) strategy.

The event log stores the following information:

- ventilation starts and stops
- confirmed ventilator parameter settings
- confirmed alarm settings
- alarm and technical fault occurrences with associated actions such as audio paused, alarm reset, and alarm paused actions, and acknowledgment key presses.

Each event is identified by its name, the type of event (technical fault or alarm event), a description of the event, and a date and time stamp.

The event log records any changes to the system's real-time clock by logging the current date/time followed by the new date/time and a unique event code indicating the change.

4.4 Troubleshooting

This section provides guidance on how to troubleshoot and correct technical faults and ventilation alarm conditions that may have been caused by hardware or patient circuit malfunctions. Table 4-2 lists technical fault error codes and Table 4-3 lists possible ventilation alarm messages along with suggested troubleshooting steps.

WARNING

Some troubleshooting steps require working with exposed electronics connected to AC or battery power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools (except for electrical measuring devices such as a DMM) from touching electrical components.

4.4.1 Troubleshooting Technical Faults

Access the technical fault log using the information provided in Section 4.3.

Table 4-2. Technical Fault Error Troubleshooting Guide

Error code	Description	Troubleshooting steps
n01	Constant flow for 1 minute; faulty inspiratory flow sensor	1. Calibrate inspiratory flow sensor (see Section 6.7.3.2). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Replace CPU PCBA (see Section 5.7.10).
n02	Inspiratory flow sensor calibration fault	1. Calibrate the inspiratory flow sensor (see Section 6.7.3.2). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Replace CPU PCBA (see Section 5.7.10).
n03	Exhalation flow sensor calibration fault	1. Verify correct patient circuit is used. 2. Re-run exhalation flow sensor calibration. 3. If running exhalation flow sensor calibration, try a new external exhalation valve and/or a new patient circuit. 4. Calibrate inspiratory flow sensor (see Section 6.7.3.2). 5. Re-calibrate the exhalation flow sensor. 6. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 7. Replace exhalation block (see Section 5.7.5). 8. Replace CPU PCBA (see Section 5.7.10).

Table 4-2. Technical Fault Error Troubleshooting Guide (continued)

Error code	Description	Troubleshooting steps
n04	Internal valve (exhalation solenoid valve) pressure sensor calibration fault	1. Calibrate internal valve pressure sensor (see Section 6.7.3). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Replace CPU PCBA (see Section 5.7.10).
n05	Internal pressure sensor calibration fault	1. Calibrate internal pressure sensor (see Section 6.7.3). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Replace CPU PCBA (see Section 5.7.10).
n06	Abnormal turbine speed measurement-Defect sensor speed	1. Perform Flow Sensor Capacity test (see Section 6.8.1). 2. Check that the turbine motor wiring harness is connected to the turbine control PCBA (J2), and that the cable between the turbine control PCBA (J22) and the CPU PCBA (J4) is connected. 3. Verify 24V is present on the turbine control PCBA connector J1 pin1 (-) and pin 2 (+). 4. Verify 24V output on Power Management PCBA [connector J9, pin 1 (-) and pin 2 (+)] 5. Check fuse F1 on turbine control PCBA. Replace if necessary. 6. Replace turbine control PCBA/ CPU cable. 7. Replace turbine (see Section 5.7.19). 8. Replace turbine control PCBA (see Section 5.7.20). 9. Replace CPU PCBA (see Section 5.7.10).
n07	Loss of clock parameters.	1. Reset the date and time (see Section 2.12). 2. Replace the 3V battery on the CPU PCBA (see Section 5.7.12). 3. Replace CPU PCBA (see Section 5.7.10).

Table 4-2. Technical Fault Error Troubleshooting Guide (continued)

Error code	Description	Troubleshooting steps
n08	Proximal pressure sensor calibration fault.	1. Calibrate proximal pressure sensor (see Section 6.7.3). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Verify proper tubing connections. 4. Replace CPU PCBA (see Section 5.7.10).
n09	Negative proximal pressure measurement for 15 seconds.	1. Calibrate proximal pressure sensor (see Section 6.7.3). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Replace CPU PCBA (see Section 5.7.10).
n10	Negative internal pressure measurement for 15 seconds.	1. Calibrate internal pressure sensor (see Section 6.7.3). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Replace CPU PCBA (see Section 5.7.10).
n11	Negative internal valve (exhalation solenoid valve) pressure measurement for 15 seconds.	1. Calibrate internal valve (see Section 6.7.3). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Check the voltage across the exhalation solenoid valve (J19) connector pins on CPU PCBA. If 24 V is not present, replace exhalation solenoid valve, otherwise replace CPU PCBA (see Section 5.7.10).
n12	Loss of memory event pointers.	1. Replace CPU PCBA (see Section 5.7.10).
n13	FiO_2 sensor offset fault	1. Calibrate FiO_2 sensor (see Section 6.11).

4.4.2 Troubleshooting Ventilation Alarm Messages

Table 4-3 lists possible ventilation alarm messages (in alphabetical order), alarm detection method and ventilator response, priority and whether they respond to the audio paused and/or alarm paused functions and suggests troubleshooting steps for possible hardware or patient circuit causes. See the *Puritan Bennett 560* Ventilator *Clinician's Manual* for appropriate responses to alarms when the ventilator is being used on a patient. The alarm message text shown appears when you have configured the ventilator for English in the SETUP menu.

If medium, high, or very high priority is listed for an alarm, the priority refers to the alarm LEDs and tones. Very high priority means the red alarm LED is continuously illuminated with a continuous alarm tone, and ventilation stops. High priority means the red alarm LED flashes with five alarm tones, and medium priority means an orange LED flashes with three alarm tones. If the ventilator gives a visual priority, then no LED is illuminated nor do alarm tones annunciate. Only an alarm message appears on the screen.

Some alarm messages appear with an asterisk (*) after the first part of the message and before the second part of the message. This indicates that an alarm message contains more information than can be displayed on a single screen. These messages scroll to display the additional information.

Access the alarm log using the information provided in Section 4.3.

Note:

All alarm messages listed are in US English language as set in Preferences Menu.

Table 4-3. Ventilation Alarm Troubleshooting Guide

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
AC POWER DISCONNECTION	Loss of AC power • If CHECK SUPPLY alarm is OFF, immediately detected. If CHECK SUPPLY alarm is ON, detected after 5 seconds if ventilation is stopped or • Detected at the start of inspiration when ventilation is in progress. Ventilator response: Switch to external DC power supply if present, otherwise to internal battery. Automatically clears when AC power returns.	Medium Priority/ Yes/Yes	1. Verify the presence of AC power at the wall outlet. 2. Check the continuity of the AC power cord. 3. If AC LED is illuminated, check the voltage across the 24V fuse (FU2) on the CPU PCBA. If voltage is correct, consider replacing CPU PCBA (see Section 5.7.10). If voltage is incorrect, consider replacing Power Management CPU PCBA (see Section 5.7.22).
APNEA	No inspiratory trigger detected by the ventilator and Apnea setting in Preferences menu is set to YES Apnea occurs in PSV ST; V SIMV; P SIMV; CPAP	Medium Priority/ Yes/ Yes	1. Check ventilator operation using a known good patient circuit and test lung. 2. Replace the inlet air filter (see Section 5.7.1). 3. Verify flow and pressure sensor calibration (see Section 6.7.3). Calibrate as necessary. 4. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator.

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
BATTERY FAULT1 RESTART/SRVC	Detection of a fault in the internal battery. Ventilator response: Internal battery is disabled from use. A **-** symbol appears beside the battery symbol instead of remaining internal battery capacity.	Medium Priority/ Yes/Yes	1. Try to operate the ventilator on internal battery only (unplug from AC power). If the ventilator does not run, replace battery. If ventilator runs proceed to step 2. Check the battery voltage using the Internal Battery Menu in the Measurements Check screen in Maintenance mode (see Section 6.7.2). • If displayed battery voltage is greater than upper battery voltage spec limit (29.4 V ±1%) remove battery (see Section 5.7.4) and measure voltage. If measured voltage is less than displayed voltage, check the 24 V output (J7) pin 1 (-) and pin 3 (+) of the power management PCBA. • If 24 V output is out of range, consider replacing CPU PCBA (see Section 5.7.10) or Power management PCBA (see Section 5.7.22). If displayed battery voltage is below 25V, remove the battery and measure voltage. Replace battery if voltage is less than 25 V (see Section 5.7.4). • If displayed battery voltage is below 25V but measured battery voltage is > 28 V, check the voltage at connector J10, pins 1 (-) and 9 (+) on the Power Management PCBA. If this measurement matches the measured battery voltage, consider replacing Power Management PCBA (see Section 5.7.22), otherwise replace Battery Connection PCBA (see Section 5.7.24).

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
BATTERY FAULT2 RESTART/SRVC	No internal battery detected. Ventilator response: A - symbol appears beside the battery symbol instead of remaining internal battery capacity.	Medium Priority/ Yes/No	1. Install a battery. 2. Replace Battery Connection PCBA (see Section 5.7.24). 3. Replace Power Management PCBA (see Section 5.7.22).
BATTERY FAULT3 RESTART/SRVC	Immediately detected if ventilator does not recognize the battery as a Puritan Bennett supplied battery	Medium Priority/ Yes/No	1. Inspect battery. If Puritan Bennett battery is installed, replace with new Puritan Bennett battery. If non-Puritan Bennett battery is installed, replace with a Puritan Bennett battery (see Section 5.7.4). 2. Replace Power Management PCBA (see Section 5.7.22). 3. Replace CPU PCBA (see Section 5.7.10).
BUZZER FAULT1 RESTART/SRVC	Detected when there is a hardware fault on the buzzer PCBA	Medium Priority/ Yes/No	1. Switch the ventilator off and switch it on again. If alarm persists go to Step 2. If alarm clears, the device is safe for use. 2. Switch the ventilator on (no need to ventilate) for a minimum of 15 minutes and up to two hours. Switch the ventilator off and switch it on again. If the alarm does not trigger again, the device is safe for use. If alarm persists go to Step 3. 3. Switch the ventilator off and switch it on again in Setup mode and go to Maintenance menu. Go to the Measurements Check menu, place the cursor on Buzzer Voltage check, and press **ENTER**. Buzzer should buzz and voltage should be 1.7 V – 2.1 V. If the voltage is out of range low or reading 0 while sounding, go to Step 4. If voltage is within range, the device is safe for use.

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	**How detected/ventilator response**	**Priority/ Audio paused/ Alarm paused**	**Troubleshooting steps**
BUZZER FAULT1 RESTART/SRVC (cont.)			4. Open device and verify and/or reseat the Buzzer PCBA cable connection to the CPU PCBA. Retest the Buzzer Voltage in Maintenance Mode / Measurement Check (Per step 3, check buzzer voltage). If vent continues to fail go to Step 5. Replace Buzzer PCBA (see Section 5.7.15). 5. Replace CPU PCBA (see Section 5.7.10).
BUZZER FAULT2 RESTART/SRVC	Watchdog (Power Fail Interrupt) voltage > 30 V. Failure detected in the watchdog circuitry which would prevent the Very High Priority alarm from audibly annunciating in the event of a loss of power during ventilation. Ventilator response: No audio signaling for Very High Priority alarms	Medium Priority/ Yes/Yes	Check watchdog voltage in Maintenance mode (see Section 6.7.2). If watchdog voltage >30 V, replace Power Management PCBA (see Section 5.7.22). If watchdog voltage < 30 V, replace CPU PCBA (see Section 5.7.10).
BUZZER FAULT3 RESTART/SRVC	Buzzer battery charging failure (voltage < 4.8 V). Occurs when a hardware fault is detected on battery charger of the buzzer PCBA.	High Priority/ Yes/No	1. Ensure the alarm switch is properly set. See Section 5.7.15 to properly set the switch. 2. Consider replacing Buzzer PCBA (see Section 5.7.15). If alarm persists, replace ventilator.

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
BUZZER LOW BATTERY	Buzzer battery voltage <4.8 V with no failure of alarm battery and alarm battery charging circuit. When this alarm occurs, the Power Supply Loss (VHP) alarm cannot annunciate in the event that the ventilator's power switch is turned off during ventilation. Re-sets when voltage > 4.9 V.	Medium Priority/ Yes/Yes	1. Switch the ventilator off and switch it on again. If alarm persists go to Step 2. If the alarm clears, the device is safe for use. 2. Switch the ventilator on (no need to ventilate) for a minimum of 15 minutes and up to two hours. Switch the ventilator off and switch it on again. If the alarm does not trigger again, the device is safe for use. If alarm persists go to Step 3. 3. Check the orientation of the switch on the Buzzer PCBA (see Figure 5-23) and be sure that it is set to the left as shown. If ventilator continues to fail, go to Step 4. 4. Replace Buzzer PCBA (see Section 5.7.15). If alarm persists, replace ventilator.
CALIBRATION FAIL	Failure of an exhalation flow sensor calibration point. Ventilator response: the failed calibration point is replaced by the default value and ventilator continues the calibration process at the next flow point.	Medium Priority/ Yes/Yes	1. If running exhalation flow sensor calibration, try a new external exhalation valve and/ or a new patient circuit. 2. Calibrate inspiratory flow sensor (see Section 6.7.3). 3. Re-calibrate the exhalation flow sensor. 4. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 5. Replace exhalation block (see Section 5.7.5). 6. Replace CPU PCBA (see Section 5.7.10).
CHECK BATTERY CHARGE	Internal battery charging circuit fault detected. Ventilator response: Internal battery does not charge.	Medium Priority/ Yes/No	1. Check internal battery capacity by running the measurement check (see Section 6.7.2). 2. Replace Power Management PCBA (see Section 5.7.22).

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
CHECK EXH VALVE	Exhaled tidal volume < 40% of inspired tidal volume, and inspired tidal volume > 20 mL. Activation: after 15 s in V/ AC; P/AC; PSV ST; V SIMV; and P SIMV	High Priority/ Yes/No	1. Check ventilator operation with a known good patient circuit. 2. Re-calibrate exhalation flow sensor using known good exhalation block (see Section 6.7.3.3). 3. Re-calibrate internal valve pressure sensor (see Section 6.7.3). 4. Re-calibrate inspiratory flow sensor (see Section 6.7.3). 5. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 6. Verify integrity of exhalation block. Replace if necessary (see Section 5.7.5). 7. Verify integrity of inspiratory block. Replace if necessary (see Section 5.7.13). 8. Replace CPU PCBA (see Section 5.7.10), otherwise replace CPU PCBA (see Section 5.7.10).
CHECK EXH VALVE PRESSURE	Occurs when the software detects an abnormal signal from the valve pressure sensor on the CPU PCBA	High Priority/ Yes/No	1. Recalibrate internal valve pressure sensor (see Section 6.7.3). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Check the voltage across the exhalation solenoid valve (J19) connector pins on CPU PCBA. If 24 V not present, replace exhalation solenoid valve (see Section 5.7.9).

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
CHK EXH VALVE PRESSURE	Valve pressure < 1.5 cmH_2O at ventilation start. Activation: At the first breath in V A/C; P A/C; PSV ST;V SIMV; P SIMV	High Priority/ Yes/No	1. Re-calibrate internal valve pressure sensor (see Section 6.7.3). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Check the voltage across the exhalation solenoid valve (J19) connector pins on CPU PCBA. If 24 V is not present, replace exhalation solenoid valve (see Section 5.7.9), otherwise replace CPU PCBA (see Section 5.7.10).
CHECK PROXIMAL LINE 1*	• Occurs when proximal line is not connected at start of ventilation. Loss of signal from the proximal pressure sensor after one ventilation cycle or • No signal detection from the proximal pressure sensor after 17 seconds in P A/C and V A/C modes or after Apnea Time + 4 seconds in PSV ST,P SIMV, and V SIMV modes. Ventilator response: Switch to internal pressure sensor for pressure measurement.	Medium Priority/ Yes/No	1. Re-calibrate proximal pressure sensor (see Section 6.7.3). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Replace CPU PCBA (see Section 5.7.10).
CHECK REMOTE ALARM	Failure of remote alarm relay circuit.	Medium Priority/ Yes/Yes	1. Perform remote alarm test (seeSection 6.13). 2. If test fails, replace CPU PCBA (see Section 5.7.10)

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
CHECK SETTINGS	Immediately detected upon loss of memorized parameters or after installation of a new ventilator software version or Setting out of range or loss of SETUP menu settings Ventilator response: Deactivates software lock; out-of-range settings replaced by default values	Medium Priority/ Yes/Yes	1. Re-enter ventilation parameters. 2. Turn ventilator off and back on again to verify memory. If settings are not retained, replace CPU PCBA (see Section 5.7.10).
CONNECT VALVE	Occurs at ventilation start in VC, PSIMV, or VSIMV modes when the exhalation valve is not detected.	High Priority/ Yes/No	Connect an exhalation valve
CONNECT VALVE OR CHANGE PRESS	Occurs at ventilation start in PC or PSV ST when pressure settings match operation with exhalation valve configuration but the exhalation valve is not detected.	High Priority/ Yes/No	1. Install or replace exhalation valve. 2. Calibrate internal valve pressure transducer (see Section 6.7.3). 3. Replace CPU PCBA (see Section 5.7.10).
COOLING FAN RESTART / SRVC	Ventilator cooling fan operating speed is not appropriate for the internal device temperature	Medium Priority/ Yes/Yes	1. Verify fan spins freely. Replace if necessary (see Section 5.7.23). 2. Verify 24 V output at fan connector (J6). If voltage is incorrect, replace Power Management PCBA (see Section 5.7.22). 3. Replace CPU PCBA (see Section 5.7.10).
CPAP MODE	Occurs when CPAP ventilation is started and an exhalation valve is used.	High Priority/ Yes/No	Remove exhalation valve.

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
DC POWER DISCONNECTION	Loss of external DC power. Activation: After 5 seconds if ventilation is stopped or at the start of inspiration when ventilation is in progress. Ventilator response: Switch to internal battery.	Medium Priority/ Yes/Yes	1. Verify the voltage at the external power source and re-charge as necessary. 2. If DC source has power available, but DC LED is not illuminated, replace Power Management PCBA (see Section 5.7.22). 3. If DC LED is illuminated, remove the fuse and check continuity (FU2 on the CPU PCBA). If continuity is good, replace CPU PCBA (see Section 5.7.10). 4. If 24 V not present, replace Power Management CPU PCBA (see Section 5.7.22).
DEVICE FAULT1 RESTART/SRVC	Internal pressure sensor signal constant (± 0.5 cmH_2O) for 15 seconds.	High Priority/ Yes/No	1. Re-calibrate internal pressure sensor (see Section 6.7.3.1). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Replace CPU PCBA (see Section 5.7.10).
DEVICE FAULT2 RESTART/SRVC	Proximal pressure sensor signal constant (± 0.5 cmH_2O) for 15 seconds.	Medium Priority/ Yes/No	1. Re-calibrate proximal pressure sensor (see Section 6.7.3.1). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Replace CPU PCBA (see Section 5.7.10).
DEVICE FAULT3 RESTART / SRVC	24 V failure	High Priority/ Yes/No	1. Check 24V output at connector J9 pin 1 (-) and pin 2 (+) on Power Management PCBA. If 24 V not present, replace Power Management PCBA (see Section 5.7.22).
DEVICE FAULT4 RESTART/SRVC	Ventilator cooling fan operating speed is not appropriate for the internal device temperature.	Medium Priority/ Yes/Yes	1. Verify fan spins freely. Replace if necessary (see Section 5.7.23). 2. Verify 24 V output at fan connector (J6). If voltage is incorrect, replace Power Management PCBA (see Section 5.7.22). 3. Replace CPU PCBA (see Section 5.7.10).

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
DEVICE FAULT5 RESTART / SRVC	Detection of a fault in the electrical power supply system. Ventilator response: A ▬ symbol appears beside the battery symbol instead of remaining internal battery capacity	Medium Priority/ Yes/Yes	Replace Power Management PCBA (see Section 5.7.22).
DEVICE FAULT6 RESTART / SRVC	Turbine speed too low coupled with high internal temperature. Ventilator response: ventilation stops within 5 seconds; oxygen solenoid valve closes	High Priority/ No/No	1. Verify electrical connection at J1 on Turbine PCBA and that 24 V is present. If not present consider replacing: • Power Management PCBA (see Section 5.7.22) • Turbine control PCBA (see Section 5.7.20) 2. Check the fuse, F1, on the turbine control PCBA. If fuse is blown, replace turbine control PCBA (see Section 5.7.20). 3. Check connection and cable between turbine control PCBA and CPU PCBA. Replace cable if necessary. 4. Replace turbine (see Section 5.7.19). 5. Replace CPU PCBA (see Section 5.7.10).
DEVICE FAULT7 RESTART / SRVC	CPU 5 V reference voltage < 4.5 V or 10 V reference voltage < 9 V	High Priority/ Yes/No	1. Consider replacing: • Power Management PCBA (see Section 5.7.22). • CPU PCBA (see Section 5.7.10).
DEVICE FAULT8 RESTART/SRVC	Inspiratory flow is constant (±1 lpm) with normal turbine temperature and speed conditions	High Priority/ Yes/No	1. Re-calibrate inspiratory flow sensor (see Section 6.7.3.1). 2. Consider replacing CPU PCBA (see Section 5.7.10).
DEVICE FAULT9 RESTART/SRVC	RAM error during POST	Very High Priority/ No/No	1. Consider replacing CPU PCBA (see Section 5.7.10).
DEVICE FAULT10 RESTART/SRVC	Flash memory checksum error during POST	Very High Priority/ No/No	1. Consider replacing CPU PCBA (see Section 5.7.10).

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
DEVICE FAULT11 RESTART/SRVC	EEPROM error during POST	Very High Priority/ No/No	1. Consider replacing CPU PCBA (see Section 5.7.10).
DEVICE FAULT12 RESTART/SRVC	Reference voltage error during POST	Very High Priority/ No/No	1. Consider replacing CPU PCBA (see Section 5.7.10).
DEVICE FAULT13 RESTART/SRVC	Software does not carry the LX xxxxxx designation. Activation: At ventilator startup during POST. Ventilator response: Ventilation prohibited.	Very High Priority/ No/No	1. Contact your local Covidien service representative.
EMPTY BATTERY	Internal battery capacity < 10 min. or 3% (battery voltage < 22.5 V) Ventilator response: Ventilation stops immediately	High Priority/ No/No	1. Charge the battery by connecting the device to AC power. 2. Replace the battery (see Section 5.7.4). 3. Replace battery connection PCBA (see Section 5.7.24). 4. Replace Power Management PCBA (see Section 5.7.22).
E SENS FAULT OR CIRC LEAK	At least 4 of the last 6 breaths within the last minute are terminated by time in P SIMV or V SIMV modes.	Medium Priority/ Yes/No	1. Check for leaks at all tubing connections inside the ventilator. 2. Replace CPU PCBA (see Section 5.7.10).

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
EXH VALVE LEAKAGE	Exhaled flow detected during the inspiratory phase for three consecutive breaths (using double-branch patient circuit) in V A/C; P A/C; PSV ST; V SIMV; P SIMV	Medium Priority/ Yes/No	1. Check ventilator operation with a known good patient circuit. 2. Re-calibrate exhalation flow sensor using known good exhalation block (see Section 6.7.3.3). 3. Re-calibrate internal valve pressure sensor (see Section 6.7.3.1). 4. Re-calibrate inspiratory flow sensor (see Section 6.7.3.2). 5. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 6. Verify integrity of exhalation block. Replace if necessary (see Section 5.7.5). 7. Verify integrity of inspiratory block. Replace if necessary (see Section 5.7.13). 8. Replace CPU PCBA (see Section 5.7.10).
ERASE ERROR TECHNICAL PROBLEM	Occurs if the memory erase operation on USB memory device fails.	Visual priority/ No/No	Try another USB memory device.
HIGH INT TEMP COOL VENT*	Device internal temperature out of tolerance range. (> 60^{o}C)	Medium Priority/ Yes/Yes	1. Check device internal temperature on the Measurements Check menu in Maintenance mode (see Section 6.7.2). If displayed temperature > 140 °F (60° C), move device to cooler location. 2. Replace Power Management PCBA (see Section 5.7.22). 3. Replace CPU PCBA (see Section 5.7.10).

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
HIGH/LOW BATTERY TEMP*	Battery temperature out of tolerance. Ventilator response: Battery charging stops.	Medium Priority/ Yes/Yes	1. Check battery temperature displayed on Internal Battery menu in Measurements Check menu of Maintenance mode (see Section 6.7.2). If temperature > 104 °F (40 °C) or < 41 °F (5 °C), move device to cooler or warmer location as appropriate. 2. Verify internal fan is operating. 3. Consider replacing: • Power Management PCBA (see Section 5.7.22). • CPU PCBA (see Section 5.7.10). • Battery (see Section 5.7.4).
INCOMPATIBLE SOFTWARE VERSION	Occurs at startup when a hardware problem is detected on CPU PCBA memories or critical CPU functions. Also occurs on start up after software download with corrupted software or with software that is not suitable for PB560 ventilator.	High Priority/ No/No	1. Contact your local Covidien representative.
INSP FLOW RESTART / SRVC	Inspiratory flow is constant (±1 lpm) with normal turbine temperature and speed conditions	High Priority/ Yes/No	1. Re-calibrate inspiratory flow sensor (see Section 6.7.3.2). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Consider replacing CPU PCBA (see Section 5.7.10).
INTENTIONAL VENT STOP	Detected when ventilator is shut down with the power switch while ventilating. Alarm lasts until the next power-on.	High Priority/ Yes/Yes	Ensure that ventilator was shut down intentionally.
KEYBOARD FAULT RESTART / SRVC	Key pressed for more than 45 seconds (stuck key).	High Priority/ No/No	1. Replace keypad (see Section 5.7.8). 2. Replace CPU PCBA (see Section 5.7.10).

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
LOW BATTERY	Internal battery capacity < 30 min. or 8% (battery voltage < 25 V)	High Priority/ Yes/No	1. Charge the battery by connecting the device to AC power. 2. Replace battery (see Section 5.7.4). 3. Replace battery connection PCBA (see Section 5.7.24). 4. Replace Power Management PCBA (see Section 5.7.22).
NO BATTERY DETECTED	Immediately detected when no battery is installed	Medium Priority/ Yes/No	Install Covidien approved battery.
NO PROXIMAL LINE2*	Proximal pressure < 0.6 cmH_2O for 100 ms during inspiration phase of 2nd breath cycle Ventilator response: Switch to internal pressure sensor for pressure measurement. • Occurs when proximal line is not connected during ventilation. Loss of signal from the proximal pressure sensor after one ventilation cycle or • No signal detection from the proximal pressure sensor after 17 seconds in P A/C and V A/C modes or after Apnea Time + 4 seconds in PSV ST,P SIMV, and V SIMV modes. Ventilator response: Switch to internal pressure sensor for pressure measurement.	Medium Priority/ Yes/No	1. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 2. Re-calibrate proximal pressure sensor (see Section 6.7.3.1). 3. Replace CPU PCBA (see Section 5.7.10).

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
OCCLUSION CHECK CIRCUIT*	Less than 20 mL of inspired tidal volume and P Support or Pi -20% < Pi < P Support or Pi+20% measured for three consecutive breaths in PSV ST, P A/C, and P SIMV modes. **Note:** A high respiratory rate or backup rate may not sufficiently flush out CO_2 in some vented pediatric masks.	High Priority/ Yes/No	1. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator or in patient circuit. 2. Ensure the patient circuit matches the set ventilator preference (Use pediatric circuit when pediatric circuit preference set to YES; use adult circuit when Pediatric circuit preference set to OFF). 3. Switch to a vented system with a larger leak configuration. 4. Re-calibrate inspiratory flow sensor (see Section 6.7.3). 5. Replace CPU PCBA (see Section 5.7.10).
PATIENT DISCONNECTION*	Activates if one of the following conditions remains for 15 s or Apnea Time + 2 seconds, whichever is greater: Inspiratory flow > 130 lpm during the inspiratory phase or • In V A/C and V SIMV modes, patient pressure ≤ Low PIP or • In PSV ST, CPAP, P A/C, and P SIMV modes patient pressure < (inspiratory pressure set point) - 20%.	High Priority/ Yes/No	1. Re-calibrate the patient and internal pressure sensors (see Section 6.7.3.1). 2. Verify all internal tubes are connected properly to their respective sensors. 3. Check for n06 technical fault. If present, replace turbine (see Section 5.7.19). 4. Replace CPU PCBA (see Section 5.7.10).
POWER FAULT RESTART/SRVC	A detection of a fault in the electrical power supply system. A- symbol displayed instead of battery capacity. Occurs when communication between CPU PCBA and Power Management PCBA is lost.	Medium Priority/ Yes/Yes	1. Replace Power Management CPU PCBA (see Section 5.7.22). 2. 2. Replace CPU PCBA (see Section 5.7.10).

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
POWER LOSS (no message)	Electrical power interrupted when ventilation is in progress or • Ventilator operating on internal battery and battery fully discharged or • stopping the ventilator without using the power switch • Ventilator response: Immediate loss of ventilation. Ventilation resumes after AC or DC power is restored or when power switch is turned on and vent is connected to AC power	VHP/No—Alarm Cancel Only/No—Alarm Cancel Only	1. Press the Alarm Control key to pause the audible portion of the alarm. 2. Turn the ventilator power switch back on to immediately resume ventilation. 3. Press and hold the Ventilation ON/OFF key for 3 seconds to stop ventilation. Confirm stop by pressing the Ventilation ON/OFF key again.
PRES SENS FLT1 RESTART/SRVC	Internal pressure sensor signal constant (± 0.5 cmH_2O) for 15 seconds.	High Priority/ Yes/No	1. Re-calibrate internal pressure sensor (see Section 6.7.3). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Replace CPU PCBA (see Section 5.7.10).
PROX SENS FLT2 RESTART/SRVC	Proximal pressure sensor signal constant (± 0.5 cmH_2O) for 15 seconds	Medium Priority/ Yes/Yes	1. Re-calibrate proximal pressure sensor (see Section 6.7.3). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Replace CPU PCBA (see Section 5.7.10).
REMOTE ALARM FAULT	Failure of remote alarm relay circuit.	Medium Priority/ Yes/Yes	1. Replace CPU PCBA (see Section 5.7.10).
REMOVE VALVE	Occurs in CPAP if ventilator detects an exhalation valve is being used.	High Priority/ Yes/No	1. Remove exhalation valve.

Table 4-3. Ventilation Alarm Troubleshooting Guide (continued)

Alarm message	How detected/ventilator response	Priority/ Audio paused/ Alarm paused	Troubleshooting steps
REMOVE VALVE OR CHANGE PRESS	Occurs in P A/C;PSV ST when pressure settings match operation with calibrated leak configuration but an exhalation valve is detected	High Priority/ Yes/No	1. Remove exhalation valve.
TRANSFER ERROR USB DISCONNECTION	Occurs when USB memory device is disconnected during data transfer.	Visual priority/ No/No	1. Reinsert USB device and retry.
TRANSFER ERROR USB FULL	Occurs when USB memory device is full during data transfer	Visual priority/ No/No	1. Delete USB device contents and retry. 2. Try a new USB device.
TRANSFER ERROR TECHNICAL PROBLEM	Occurs if a data transmission failure occurs during transfer	Visual priority/ No/No	1. Try a new USB device.
TRANSFER NOT ALLOWED INCOMPATIBLE SETTINGS	Occurs on data transfer request from the USB memory device to the ventilator when the setting file to be imported is not suitable for PB560	Visual priority/ No/No	1. Ensure the USB device has been configured for FAT 32 format.
TRANSFER NOT ALLOWED FILE NOT FOUND OR WRONG	Occurs on data transfer request from the USB memory device to the ventilator when there is no setting file on the USB memory device or if file's data are corrupted.	Visual priority/ No/No	1. Ensure the USB device has been configured for FAT 32 format. 2. Try a new USB device.
TRANSFER NOT ALLOWED REMOVE A KEY	Occurs when more than one USB memory device is connected to the ventilator.	Visual priority/ No/No	1. If two USB keys are connected to the ventilator, remove one key.
VALVE MISSING	Occurs at ventilation start in V/AC; PSIMV; or VSIMV modes when the exhalation valve is not detected	High Priority/ Yes/No	1. Verify exhalation valve is connected to exhalation valve pilot port. 2. Check for disconnected tubing inside ventilator.
VTI NOT REACHED*	Inspired tidal volume does not match Vt setting (± 10%) for six consecutive breaths in V A/C and V SIMV modes.	High Priority/ Yes/No	1. Re-calibrate inspiratory flow sensor (see Section 6.7.3). 2. Check that there are no leaks or obstructions in the pneumatic tubes inside the ventilator. 3. Replace CPU PCBA (see Section 5.7.10).

4.4.3 Troubleshooting Miscellaneous Symptoms

Table 4-4 provides information to troubleshoot faults that may or may not cause alarms or technical faults.

Table 4-4. Miscellaneous Symptom Troubleshooting Guide

Symptom	Troubleshooting steps
AC, DC, and internal battery LEDs lit in the presence of a connected AC or DC power source.	1. Consider replacing CPU PCBA (see Section 5.7.10).
LED indicating power source is not lit, but device functions.	2. Check that the keypad cable is correctly connected to connector (J1) on the CPU PCBA. Check for broken LEDs, damaged keypad cable. If LEDs are broken or cable damaged, replace keypad (see Section 5.7.8). 3. Replace CPU PCBA (see Section 5.7.10).
Excessive heat from the ventilator	1. Check the air inlet for obstructions and clear if necessary. 2. Replace the inlet air filter (see Section 5.7.1). 3. Perform the Flow Sensor Capacity test (See Section 6.8.1). 4. Replace turbine (see Section 5.7.19).
Whistling air sounds	1. Check that the inlet air filter is present. 2. Check for leaks in the oxygen connector and delivery tube. Replace tie wraps or connector or tube if necessary. 3. Replace turbine (see Section 5.7.19).
LCD panel does not update or respond to key presses	1. Verify the software lock is unlocked (see Section 4.3.2 in this chapter for instructions on how to unlock). 2. Ensure the LCD panel cable is connected properly to the CPU PCBA. 3. Replace keypad (see Section 5.7.8). 4. Verify the voltage across pins 21 (-) and 22 (+) of connector J17 on the CPU PCBA is 5 V. 5. Replace LCD panel (see Section 5.7.11). 6. Replace CPU PCBA (see Section 5.7.10).
Dark display or no display	1. Adjust display contrast and brightness. 2. If device is below specified operating temperature (See Table 2-4 for operating temperature specification), place in warmer environment. 3. Ensure the keypad cable is connected properly to the CPU PCBA. 4. Verify the voltage across pins 21 (-) and 22 (+) of connector J17 on the CPU PCBA is 5 V. 5. Replace LCD panel (see Section 5.7.11). 6. Replace CPU PCBA (see Section 5.7.10)

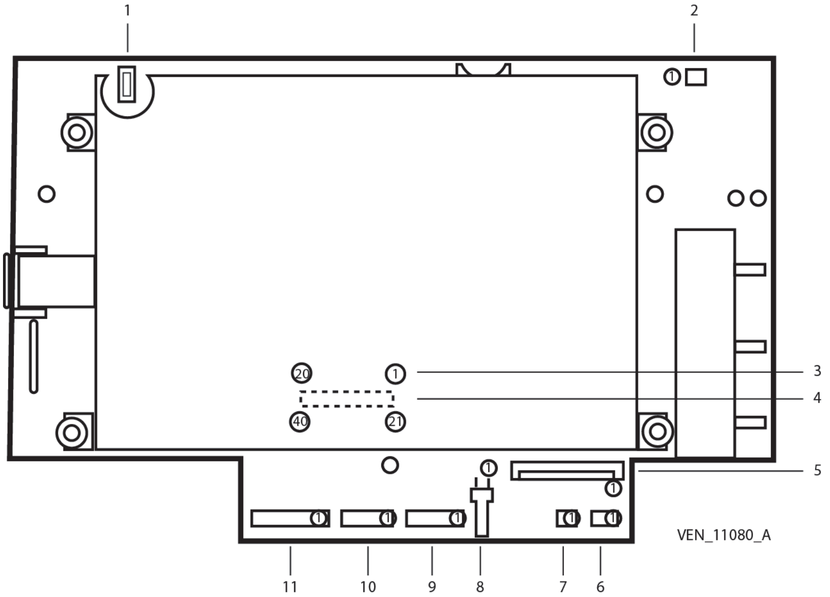
Table 4-4. Miscellaneous Symptom Troubleshooting Guide (continued)

Symptom	Troubleshooting steps
No access to waveforms	Set Display Waveforms to YES in Preferences menu (only available when ventilating.)
Display backlight does not switch off during ventilation	Set Backlight to OFF in Preferences menu.
Alarm sound level too low or too high	Adjust alarm volume level in Preferences menu.
Poor display visibility	Adjust contrast in Preferences menu.
Corrupted characters on display	Replace LCD panel (see Section 5.7.11).
Condensation appears on screen	1. Open case, let air dry, and check for failures. 2. Replace keypad (see Section 5.7.8). 3. Replace LCD panel (see Section 5.7.11).
Displayed barometric pressure does not fall within tolerance when compared with a calibrated standard barometer (fails barometric pressure test in Performance Verification).	Replace CPU PCBA (see Section 5.7.10).
Frequent inspiratory or expiratory tidal volume alarms	Ensure circuit type used (adult or pediatric) matches circuit type set in Preferences Menu

4.4.4 PCBA Test Points

Some troubleshooting steps given in Section 4.4.2 and Section 4.4.3 require you to verify voltages at various test points. The following sections provide illustrations for each PCBA showing the referenced connectors and location of pin 1 on each connector, and list the nominal voltages expected at these test points.

4.4.4.1 CPU PCBA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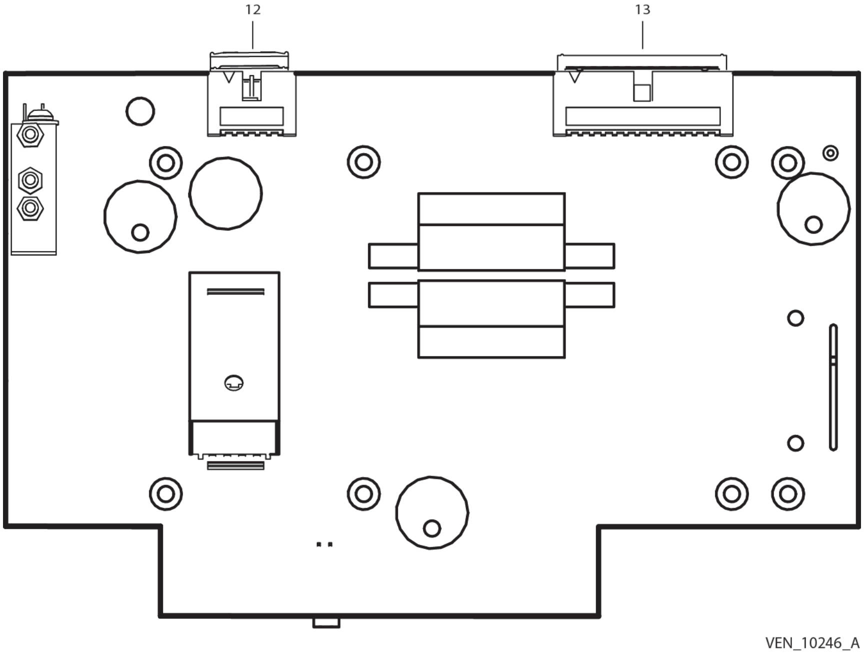
Top view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13
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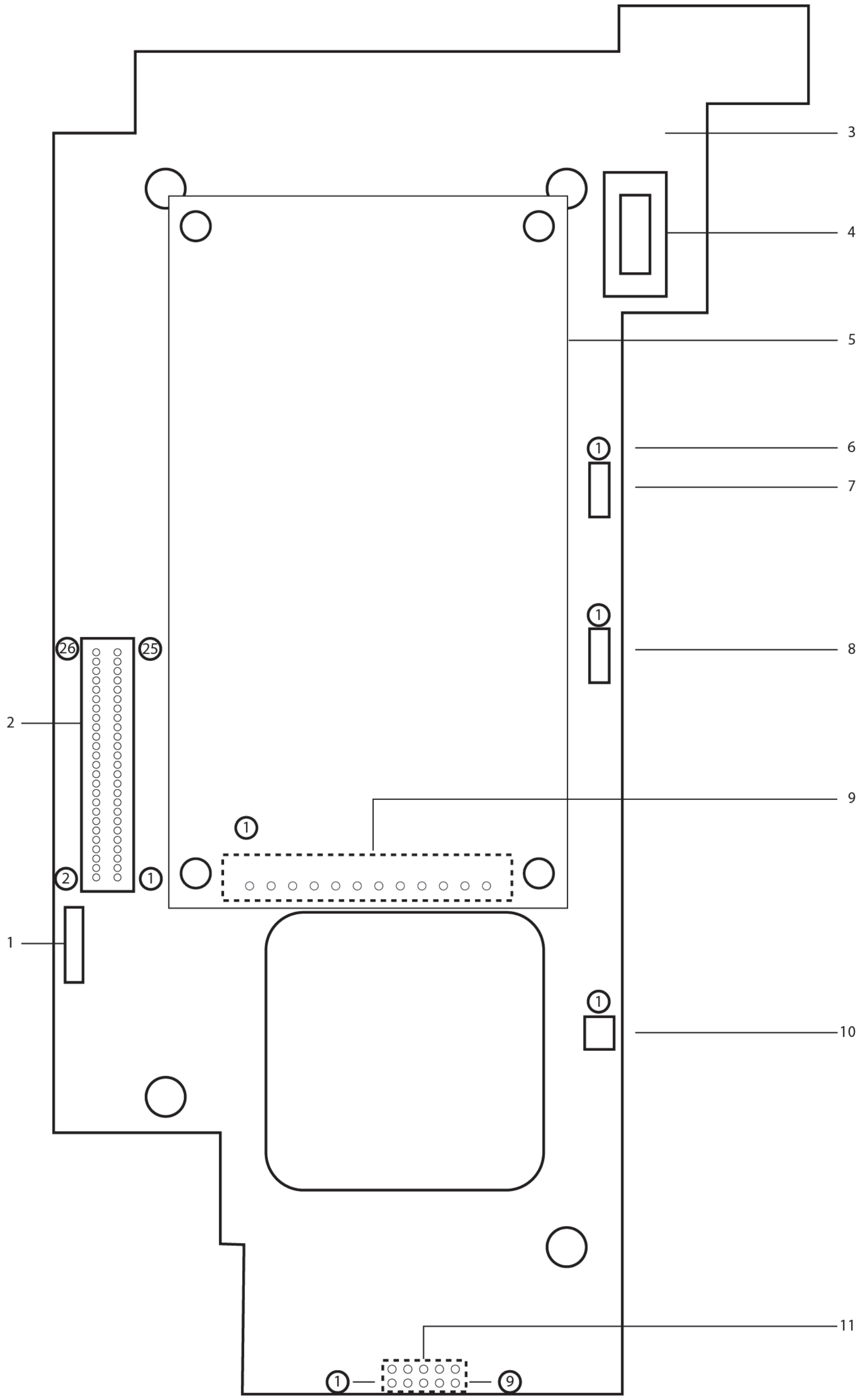
Bottom view

	Reference Designator	**Comments**		**Reference Designator**
1	FU2		**8**	J21
2	J19	Circled item number is the referenced pin of connector	**9**	J2
3		Circled item number is the referenced pin of connector	**10**	J18
4	J17	J17 located beneath CPU LCD interface PCBA under LCD panel	**11**	J3
5	J1		**12**	J4
6	J11		**13**	J7
7	J5			

Connector	**Pin (-)**	**Pin (+)**	**Nominal Voltage (v)**
J7	1	13	5
J19	2	1	24
FU2	N/A	N/A	24

4.4.4.2 Power Management PCBA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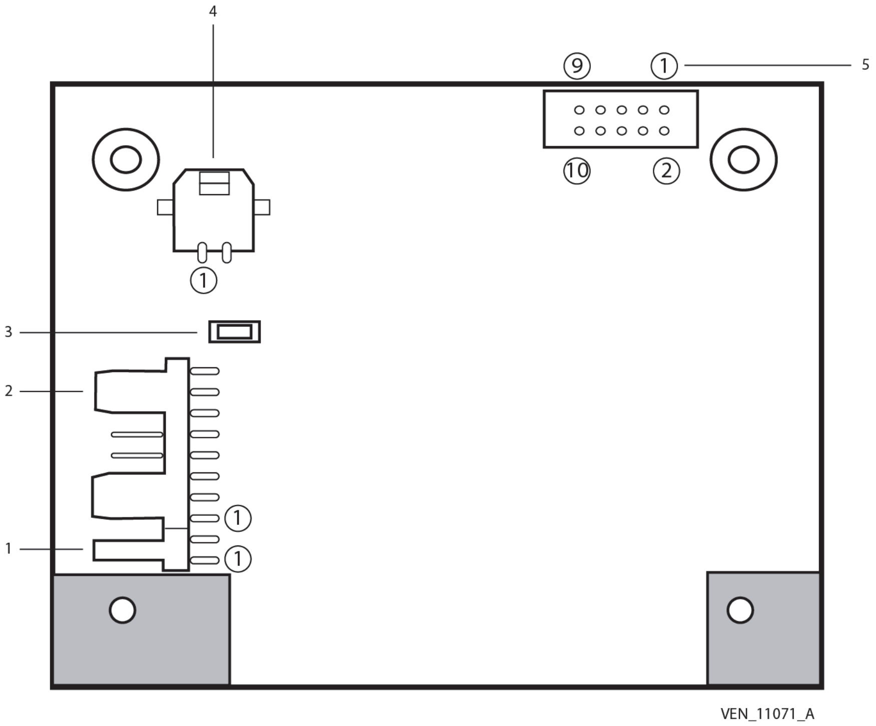
	Reference Designator	Comments		Reference Designator	Comments
1	J2		**7**	PROG EEP	
2	J7		**8**		
3		Power management PCBA	**9**	TURBINE	
4	F1		**10**		Power supply PCBA connector
5		Power Supply PCBA	**11**	VENTIL	Fan connector
6		Circled item number is the referenced pin of connector			Battery connection PCBA connector

Connector	Pin(-)	Pin (+)	Nominal Voltage (V)
J6	2	1	24
J7	1	3	24
J9	1	2	24
J10	1	9	27
J7	1	13	5

4.4.4.3 Turbine Control PCBA



	Reference Designator		Reference Designator	Comments
1	J3	**4**	J1	
2	J6	**5**		Circled item number is the referenced pin of connector (for CPU PCBA harness)
3	F1			

Connector	Pin (-)	Pin (+)	Nominal Voltage (V)
J1	1	2	24
F1	N/A	N/A	24

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5 Service and Repair

This chapter describes how to repair the major components of the Puritan Bennett™ 560 Ventilator and includes removal, replacement, and adjustment procedures. For a complete parts breakdown, including assembly drawings and part numbers, refer to Chapter 7, Parts List.

5.1 Warnings

WARNING

When servicing the ventilator, be sure to familiarize yourself with, and adhere to all posted and stated safety warning and caution labels on the ventilator and its components, and on any service equipment and materials used. Failure to adhere to such warnings and cautions at all times may result in injury or property damage.

To prevent patient injury, do not use a ventilator if it requires repair.

To prevent personal injury or death, do not attempt any ventilator service while a patient, or other person, is connected to the ventilator.

Use personal protective equipment whenever exposure to toxic fumes, vapor, dust particles, blood pathogens, and other transmittable diseases and hazardous material can be expected. If in doubt, consult an environmental health and safety specialist or an industrial hygienist before servicing the ventilator. Refer to Section 5.6.1 for cleaning procedure.

To prevent electrical shock hazard and possible personal injury, always disconnect electrical power sources before servicing the ventilator. Follow accepted safety practices for electrical equipment when testing or making equipment, adjustment, or repairs.

To prevent possible personal injury, always disconnect the oxygen source from the ventilator before service.

Chemicals from a broken LCD panel are toxic when ingested. Use caution when handling a ventilator with a broken display panel.

To prevent possible damage to the power supply, remove the battery from the ventilator (Section 5.7.4) during disassembly and reassembly.

To prevent damage to electrostatic discharge (ESD) sensitive components, always follow ESD guidelines when servicing the ventilator. Adhere to ESD control techniques when repairing ESD sensitive components.

Damage to components may occur due to over-tightening of screws. Care should be taken during reassembly not to over-tighten screws where instructed.

Use only recommended tools, test equipment, and service materials (see Table 2-14) when servicing the ventilator.

As you repair the ventilator, perform any applicable cleaning and inspection procedures listed below.

Visually inspect any removed ventilator parts, including those removed to gain access to a suspected faulty part. Inspect the exposed area behind the removed parts as well. Clean removed parts to facilitate further inspection as necessary.

Investigate and determine the cause of any detected abnormality. Repair the unit or contact Covidien Technical Support for help in diagnosing unresolved symptoms.

Replace or repair all parts that are worn, missing, damaged, cracked, corroded, burnt, warped, bent, disfigured, or broken. Consult Chapter 7 for parts availability.

Covidien recommends that customers or technical services personnel follow local governing ordinances and recycling regulations regarding disposal or recycling of the ventilator, battery, or other device components.

The repair instructions assume the patient system, humidifier, and oxygen source are already removed from the ventilator.

In the repair procedures, PCBA reference designators for connectors and sensors are given in parentheses. For example, the reference designator for the Remote Alarm connector on the CPU PCBA is (J2); the reference designator for the exhalation valve pilot pressure sensor fitting is (1 VALVE).

Do not start ventilation until you ensure the device is correctly assembled, that the air inlet filter is properly installed and unobstructed, and that there is proper clearance all around the unit. Also ensure the patient circuit is correctly connected to both the ventilator and the patient, and that the patient circuit, including all hoses, is not damaged or obstructed.

5.2 Electrical Cables and Pneumatic Tubing

- To ensure proper reassembly, note or label wire and tube positions before disconnecting parts. Refer to the pneumatic cabling diagram label on the inside of the ventilator top housing or to correctly connect pneumatic tubes.
- To avoid shredding a silicone tube when removing from a fitting, gently pull the tube while turning.
- Make sure all tubes, and harnesses or cables, are installed using tie wraps where required.
- Make sure wiring does not interfere with, and cannot be damaged by, hinged or moving ventilator parts.

5.3 Electrostatic Discharge Control

It is important to follow ESD control procedures whenever the ventilator is repaired. Electrostatic discharge can permanently damage ESD sensitive microelectronic components or assemblies when they are handled, and even when no direct contact is made with the component or assembly. ESD damage may not be immediately detectable; however, ESD damage will show up at a later time. It can manifest as a premature catastrophic failure of a component or assembly, or as an intermittent failure, all of which can be difficult and costly to locate.

5.3.1 ESD Procedures and Precautions

Follow these procedures and precautions to prevent ESD damage to the ESD-sensitive microelectronic components and assemblies in the Puritan Bennett 560 Ventilator.

- Use a personnel-grounding system. Before opening the ventilator's housings, ensure a personnel grounding system such as that listed in Table 2-14 (wrist strap, static-dissipative mat, and ground cord) is worn correctly and is properly connected to a reliable ground.
- Follow correct procedures when using an antistatic mat. Place tools, test equipment, and the ESD sensitive device on the mat before starting repairs. Conduct all work on the mat.
- Handle ESD sensitive components properly. Do not handle ESD sensitive component connection points, connector pins, leads, or terminals.
- Keep nonconducting materials away from the work area. Static charges from nonconducting material, (i.e. plastic containers, foam cups, synthetic clothing, cellophane tape, etc.) cannot be removed by grounding. These items must be kept away from the work area when handling ESD sensitive devices.
- Follow correct procedures for use of static-shielding bags. Store and transport all ESD sensitive devices in static-shielding bags at all times, except when being worked on. Never place more than one ESD sensitive device in a static-shielding bag. Never place static generating nonconducting material inside a static-shielding bag with an ESD sensitive device. Place any faulty ESD-sensitive devices in a static-shielding bag immediately after removal, to prevent additional damage. Close the bag to ensure the shield is effective.

5.4 Replacement Part Ordering

Ordering correct parts requires that you properly identify the ventilator version and part. To replace a part that is not stocked or that is unavailable, order the next higher assembly. Retain the part to be replaced until the replacement part is obtained, and compare the two for compatibility, if possible.

Chapter 7 provides lists of orderable parts and assemblies.

5.5 Patient System and Accessories

To service the patient system and accessories, refer to directions for use supplied with the patient system.

5.6 Service Prerequisites

Before repairing the ventilator, perform the tasks in this section.

5.6.1 Cleaning

The following cleaning guidelines pertain to parts that require cleaning while servicing the ventilator. Patient breathing circuits and parts listed in Table 2-2, are single patient use only, and should be disposed of when dirty. Do not clean or reuse these parts. Replace all parts that cannot be cleaned. Refer to Table 2-14 for recommended cleaning solutions.

Note:

- When cleaning reusable components, do not use hard brushes or other implements that could damage surfaces.
- After you clean the components, inspect them for damage, such as cracks and crazing. Replace any damaged components.

Note:

Discard all parts removed from the ventilator during the maintenance procedures in accordance with your institution's protocol. Sterilize or disinfect parts before nondestructive disposal. Follow local governing ordinances and recycling plans regarding disposal or recycling of device components.

To clean the ventilator

1. Clean ventilator exterior surfaces before disassembly. Table 2-14 of this manual lists acceptable cleaning and disinfecting agents.
    - Use a clean, lint-free cloth, and squeeze excess liquid from the cloth. Do not allow excess cleaning liquids to enter the ventilator.
    - Allow cleaned ventilator parts and surfaces to air-dry.
2. If required upon ventilator disassembly, vacuum ventilator interior using ESD safe equipment. Do not clean the ventilator interior or exterior surface with high-pressure air.

5.6.2 Labeling Checks

Verify the presence of the following labels and replace if necessary:

- inlet air filter label
- nurse call alarm label
- O_2 inlet label
- identification label on the bottom of the ventilator
- inspiratory block labels (exhalation pilot pressure and proximal pressure label
- exhalation block, single patient use label
- exhalation block, valve connection label.

5.6.3 External Inspection

1. Inspect the external surfaces of the ventilator for damage. Replace if necessary.
2. Check that the handle fasteners are tight. Tighten if required (if missing, refer to Section 5.7.7 for replacement).
3. Verify the presence of the following items:
    - inlet air filter (if dirty, refer to Section 5.7.1 for replacement)
    - power switch cover (if missing, refer to Section 5.7.2 for replacement)
    - four (4) feet on the bottom of the ventilator (if missing, refer to Section 5.7.3 for replacement)
    - all fasteners on the housing and battery compartment (replace as necessary).

5.6.4 Measurements Check

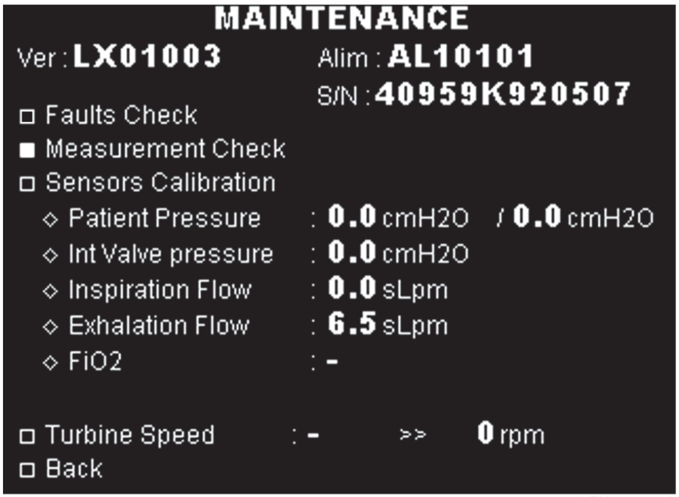
This series of steps verifies various internal voltages, including the internal battery, checks the barometric pressure sensor, and tests the alarm buzzers.

Note:
Before running the Measurement check, warm up the ventilator for at least ten minutes in normal operation (ventilating) with alarms turned off and default parameters set. This is particularly important so that the blower will be at the correct temperature during the Measurement check.

To perform the measurements check:

1. Disconnect any external DC power source, if present, and connect the ventilator to AC power.
2. Enter Maintenance mode (refer to Section 2.12 for instructions on how to enter Maintenance mode).
3. With the Maintenance screen displayed, use the **UP** or **DOWN** arrow keys to place the cursor at the Measurement Check position and press **ENTER** (Figure 5-1). The Measurements Check screen appears (Figure 5-2).

Figure 5-1. Selecting Measurement Check



MAINTENANCE

Ver : LX01003 Alim : AL10101

S/N : 40959K920507

☐ Faults Check

■ Measurement Check

☐ Sensors Calibration

◇ Patient Pressure : 0.0 cmH2O / 0.0 cmH2O

◇ Int Valve pressure : 0.0 cmH2O

◇ Inspiration Flow : 0.0 sLpm

◇ Exhalation Flow : 6.5 sLpm

◇ FiO2 : -

☐ Turbine Speed : - >> 0 rpm

☐ Back

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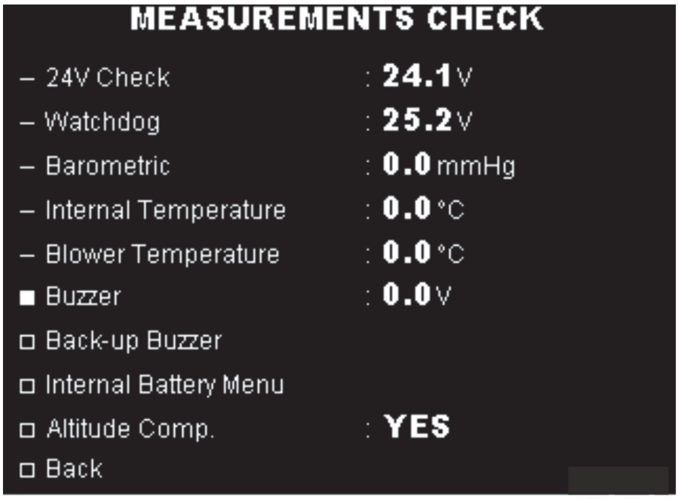
Measurement check

Figure 5-2. Measurement Check Screen



MEASUREMENTS CHECK

– 24V Check : 24.1 V

– Watchdog : 25.2 V

– Barometric : 0.0 mmHg

– Internal Temperature : 0.0 °C

– Blower Temperature : 0.0 °C

■ Buzzer : 0.0 V

☐ Back-up Buzzer

☐ Internal Battery Menu

☐ Altitude Comp. : YES

☐ Back

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4. Ensure the values are within the test limits in Table 5-1.

Table 5-1. Specifications for Measurement Check Verification

Parameter	Specification	Troubleshooting steps
24 V check	24 V ± 0.5 V	1. Verify 24 V on connector J7 (see Section 4.4.4.2) 2. Ensure Power Management cable is connected properly and is not damaged. 3. Replace Power Management PCBA (seeSection 5.7.22. 4. Replace CPU PCBA (see Section 5.7.10).
Watchdog	24 V ± 0.5 V	1. Replace CPU PCBA (see Section 5.7.10).
Barometric pressure	Ventilator barometer reading within ± 11 mmHg of reference barometer	1. Ensure no tubing is connected to the barometric pressure transducer. 2. Replace CPU PCBA (see Section 5.7.10).
Internal temperature	Internal temp 30 °C - 55 °C (86°F - 131 °F)	1. Move ventilator to a cooler location. 2. Ensure side and front cooling vents are not obstructed. 3. Ensure fan is operating properly. 4. Replace Power Management PCBA (see Section 5.7.22.)
Blower temperature	Blower temp 35 °C - 65 °C (95 °F - 149 °F)	1. Warm up the ventilator for at least ten minutes in normal operation (ventilating) with alarms turned off and default parameters set. This is particularly important so that the blower will be at the correct temperature during the Measurements check. 2. Ensure turbine control cable is connected properly and not damaged. 3. Replace turbine.
Buzzer	Long beep sounds Buzzer voltage: 1.7V - 2.1V	1. Refer to Buzzer Fault alarms in Table 4-3.
Back-up buzzer	Long beep sounds	1. Replace CPU PCBA (see Section 5.7.10.)
Altitude Compensation	Covidien recommends altitude compensation is always used (YES)	N/A

Table 5-1. Specifications for Measurement Check Verification (continued)

Parameter	Specification	Troubleshooting steps
Internal battery menu		
Supplier	Suppliers displayed	If supplier cannot be determined, replace the battery (see Section 5.7.4.)
First Use Date	Record value	N/A
Theoretical capacity	4800 mAh	If not 4800 mAh, Replace battery.
Capacity	3840 mAh minimum	If battery capacity is not at least 3840 mAh, replace battery (see Section 5.7.4.).
Cycles done	Record value	N/A
Battery voltage	23.5 V to 29.7 V following battery charge	1. Charge battery. 2. Replace battery. 3. Verify contacts and proper connection of Battery Connection PCBA and Power Management PCBA. 4. Replace Battery Connection PCBA (see Section 5.7.24). 5. Replace Power Management PCBA (see Section 5.7.22)
Battery temperature	0°C - 40°C (32°F - 104°F)	1. Check for proper operation of fan. 2. Verify cooling vents in battery cover are not obstructed. 3. Replace battery (see Section 5.7.4.).

5. With the cursor at the Buzzer position, press **ENTER**.
   a. Verify alarm emits a long beep.
   b. Verify buzzer voltage is 1.7 V to 2.1 V.
6. Place the cursor at the Back-up buzzer position and press **ENTER**.
7. Verify alarm emits a long beep.
8. Place the cursor at the Internal Battery Menu position and press **ENTER**.
9. Verify the displayed information as shown in Table 5-1. If the measurements check parameters are not as displayed in the table, refer to the Troubleshooting steps contained in that table.
10. When you have finished, place the cursor at the Back position and press **ENTER** to return to the Maintenance screen.

5.6.5 Review Technical Fault Log

To review the technical fault log:

1. Enter Maintenance mode (refer to Section 2.12 for instructions on how to enter Maintenance mode).
2. Place the cursor at the Faults Check position and press **ENTER**. The Faults screen appears. If there are no faults in the fault log, the ventilator displays NO FAULTS.
3. To return to the Maintenance screen, place the cursor at the Back position and press **ENTER**.

5.7 Ventilator Repair

This section describes how to remove major ventilator components.

5.7.1 Inlet Air Filter Removal and Replacement

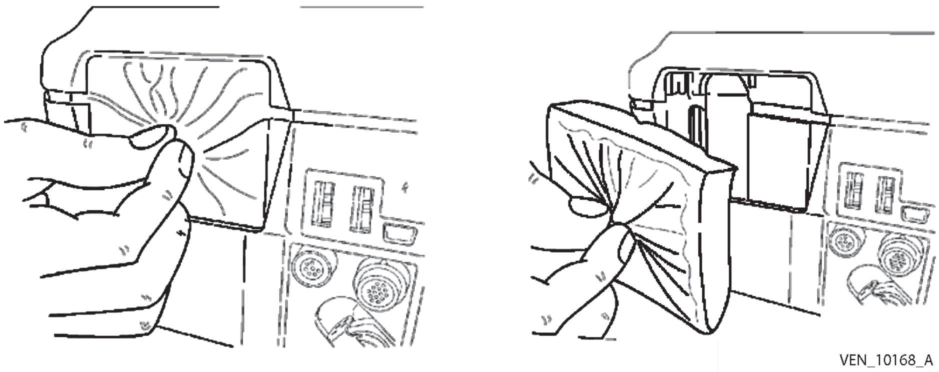
Caution

- Check the cleanliness of the inlet air filter located on the rear of the ventilator and replace it if necessary before the recommended replacement period expires. Pay particular attention when the ventilator is installed on a wheelchair, as the environmental conditions may cause the filter to become dirty more rapidly.
- Failure to replace a dirty inlet air filter or operating the ventilator without a filter may damage the ventilator.
- The inlet air filter is not reusable. Do not attempt to wash, clean, or reuse it.

To remove the inlet air filter:

Grasp the center of the filter and pull outward (Figure 5-3).

Figure 5-3. Removing the Inlet Air Filter



To replace the inlet air filter:

With the foam surface of the filter towards the ventilator, push the filter into position, tucking the corners into the housing opening. Ensure the filter is not distorted when installed.

5.7.2 Power Switch Cover Replacement

WARNING

To avoid eye injury when working with the cover spring, wear safety glasses when performing this procedure.

To remove the power switch cover:

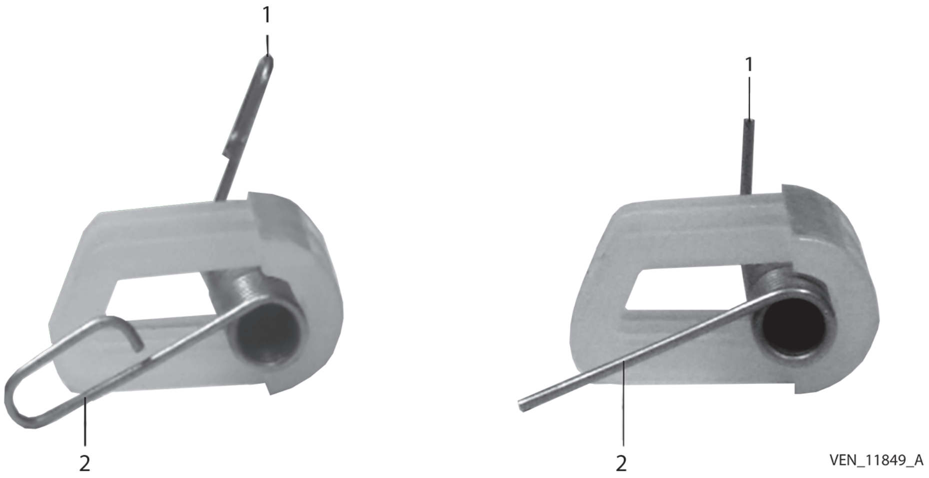
1. Grasp the power switch cover.
2. Gently pull the cover, spring, and pin assembly away from the ventilator.

To assemble the power switch cover retainer:

1. Remove the pin, spring, and switch cover from the existing switch cover assembly.

2. Assemble the spring and switch cover, ensuring proper orientation.
    a. Identify the long end of the spring and the short end of the spring. Older versions of the spring do not have a formed end, newer versions of the spring do.

Figure 5-4. Identification of Short and Long Ends of Spring



1 Long leg of spring to inside of switch cover

2 Short leg of spring to outside of switch cover

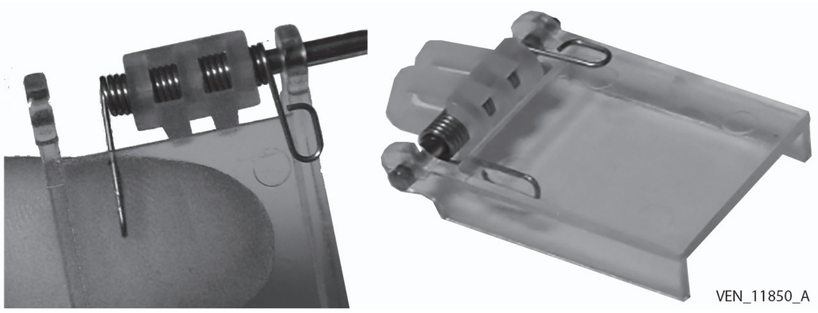
b. With the front of the switch cover out and ensuring the short end of the spring is outside the cover, slide the pin through right hole at the top of the switch cover and through the right side of the spring and the center hinge of the switch cover.

c. Twist the long end of the spring, placing the spring under tension, tucking it behind the switch cover.

d. Push the pin out the left hole at the top of the switch cover.

e. Ensure the longer leg of the spring is to the inside of the cover and the shorter leg of the spring is to the outside of the cover.

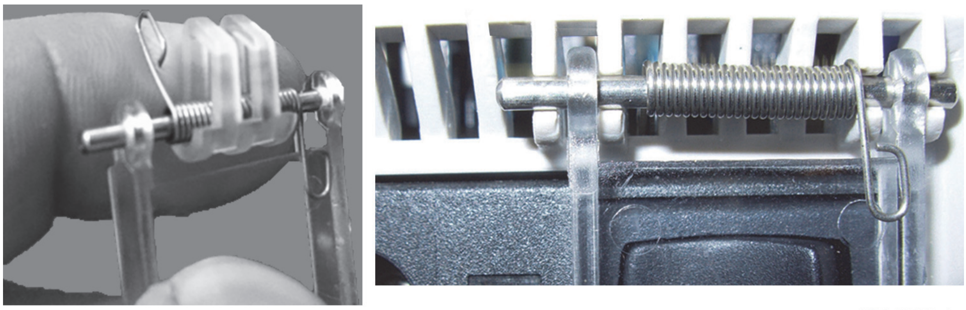
Figure 5-5. Switch cover, spring, and pin detail



To replace the power switch cover:

1. Assemble the power switch cover retainer. See "To assemble the power switch cover retainer:" on page 5-10.
2. Grasp the power switch cover, sliding an index finger under the supporting leaf.
3. Bring supporting leaf to a 90-degree position from the switch cover.

Figure 5-6. Positioning and Inserting the Switch Cover



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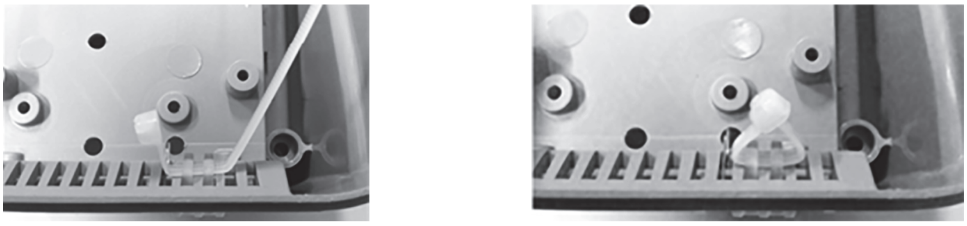
4. Insert into the rear of the lower housing, ensuring the pin and spring remain centered within the slots on the lower housing.
5. Secure the power switch cover with the provided tie-wrap.
   a. Insert tie wrap through the slots of the supporting leaf.
   b. Firmly bend the tie-wrap on both sides to prevent slippage.
   c. Secure the tie-wrap, allowing some room between the housing and the tie-wrap.
   d. Verify the switch cover is correctly attached.

Figure 5-7. Securing Switch Cover with Tie-wrap



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6. Lift and lower the cover to check that it operates correctly.

5.7.3 Adhesive Feet Removal and Replacement

To remove the adhesive feet:

1. Turn the ventilator bottom side up.
2. Use pliers to pull each foot away from the housing.

To replace the adhesive feet:

1. Clean the recess of the housing with isopropyl alcohol to remove old adhesive.
2. Peel the adhesive backing from the foot and press it into its recess (4 pl).

5.7.4 Battery Removal and Replacement

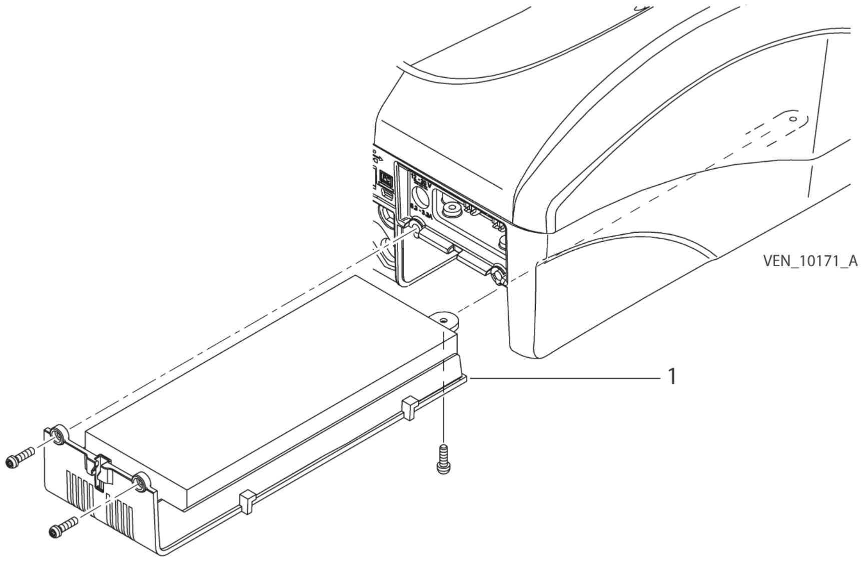
WARNING

- **Ensure the ventilator is off and AC power is disconnected when removing or installing the battery.**
- **Do not open the battery for any reason.**
- **Use care to apply proper pressure on the battery cover when installing screws.**
- **To prevent possible damage to the power supply, remove the battery from the ventilator during disassembly and reassembly.**
- **To prevent possible damage following removal, cover battery terminals in nonconductive packaging to avoid shorting and to store the battery so that it cannot be damaged.**

To remove the battery:

1. Remove the three screws from the battery cover (Figure 5-8) using a T10 Torx® driver.
2. Pull the cover out of the lower housing.
3. Remove the battery from the cover.

Figure 5-8. Removing/replacing the Battery



1	Battery contacts toward this corner

To replace the battery:

1. Install the battery so that the terminals will make contact with the Battery Connection PCBA terminals when the cover and battery are installed into the lower housing. (Figure 5-8 shows the correct orientation of the battery.)
2. Slide the battery and cover together into the lower housing. Apply pressure to the battery cover to hold in place. Use a T10 Torx® driver to install the two screws at the rear cover (do not over-tighten).
3. Install the screw at the bottom of the cover.

Note:
Dispose of used batteries according to your local governing ordinances and recycling regulations.

5.7.5 Exhalation Block Removal, Cleaning, and Replacement

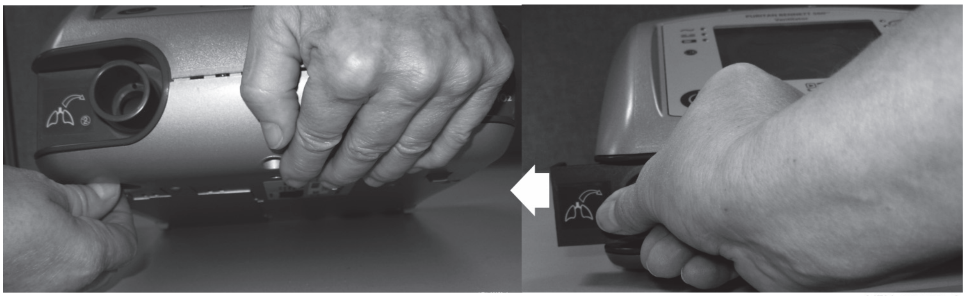
The exhalation block is for single patient use only and must not be reused with a new patient. It may, however, be removed from the ventilator, cleaned, and re-installed for use on the same patient.

To remove the exhalation block:

Refer to Figure 5-9 and perform the following steps:

1. Tilt the ventilator upward and unscrew the captive knob holding the exhalation block in place.
2. Grasp the "From patient" fitting and slide the exhalation block away from the ventilator.

Figure 5-9. Removing the Exhalation Block



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To clean the exhalation block:

1. Wash the exhalation block with warm, soapy water.
2. Remove excess water with a towel and air dry or blow dry with compressed air.

Caution

To prevent damage to the ventilator electronics, ensure the exhalation block is completely dry before reinserting it back into the ventilator.

To replace the exhalation block:

1. Slide the exhalation block into the exhalation conical fitting and ensure it is fully seated on the two connectors.
2. Tighten the captive screw to lock the exhalation block into place.

Note:

After cleaning or replacing the exhalation block, perform exhalation flow sensor calibration.

5.7.6 Housing Disassembly and Assembly

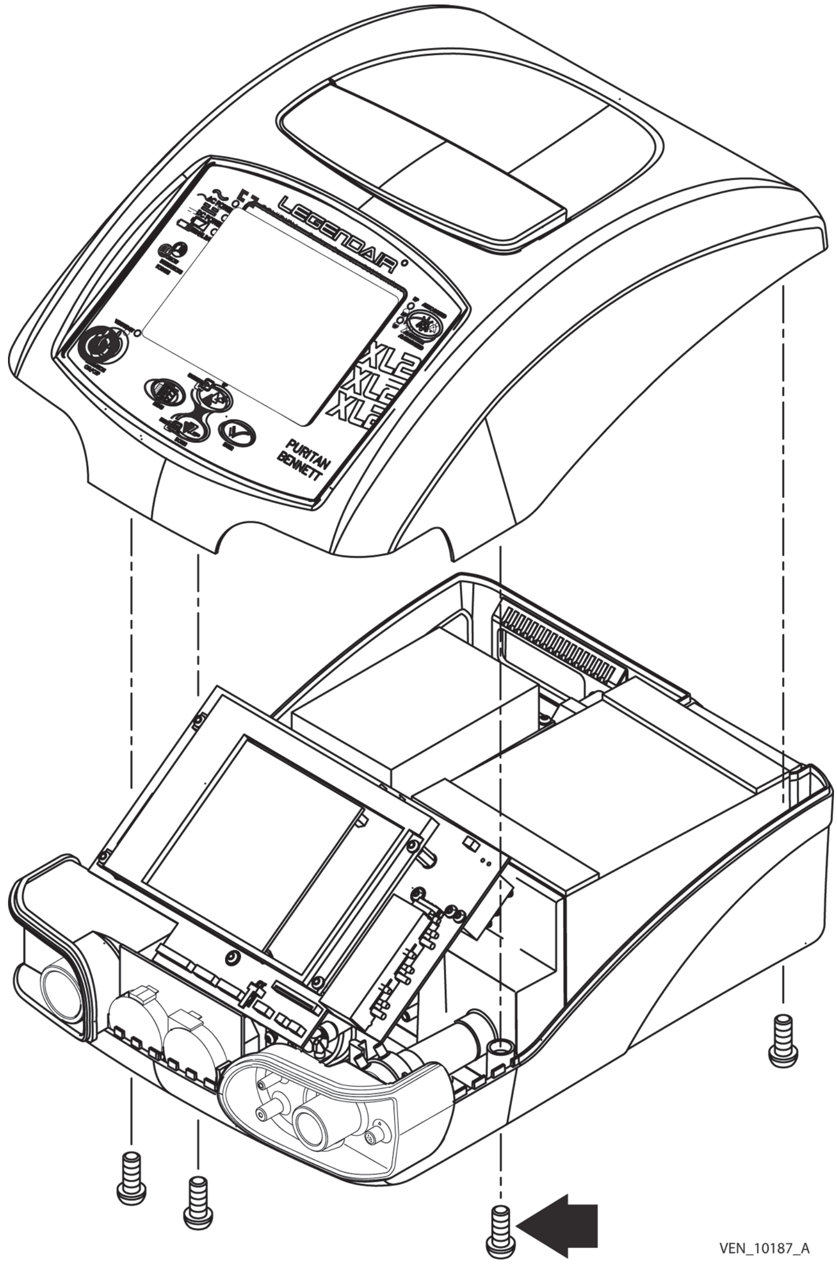
WARNING

To prevent possible injury, always remove the battery before servicing the ventilator.

To disassemble the top housing:

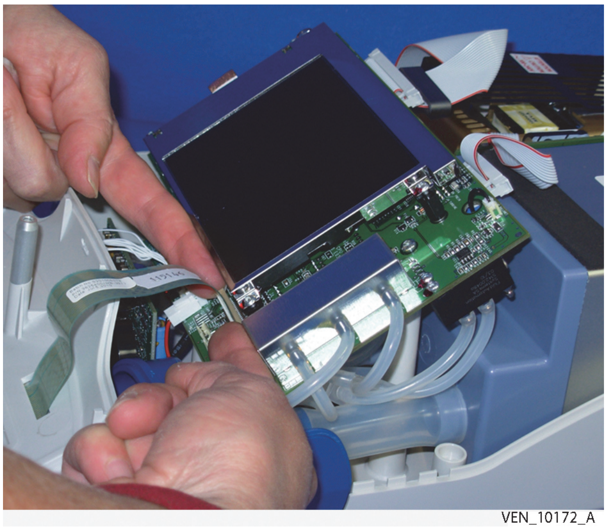
1. Place the ventilator bottom side up on the work surface, and remove the 5 screws that hold the housings together using a T20 Torx® driver (Figure 5-10). Be careful not to scratch the keypad window.
2. Turn the ventilator right side up and gently lift the top housing off the base and turn it right side down on the work surface. Be careful not to pull on the keypad flex circuit.
3. Disconnect the keypad flex circuit by lifting up on the keypad connector locking tab (J1) (located on the CPU PCBA) and sliding the circuit out of the connector ().
4. Check for the presence of the following internal ventilator labels and replace if damaged or illegible:
    - Pneumatic schematic label on the inside of the upper housing
    - Attention Caution label on the Power Management PCBA guard
    - ESD label inside the device at rear of lower housing.

Figure 5-10. Removing Top Cover


LEGENDAIR
XL2
PURITAN BENNETT
VEN_10187_A

Housing screws (5 pl)

Figure 5-11. Disconnecting the Keypad Flex Circuit



To reassemble the upper housing:

1. Slip the keypad flex circuit fully into connector J1 on the CPU PCBA and lock the connector.

Caution

To prevent possible damage, do not fold or crease the flex circuit.

2. Route the flex circuit so that it does not become pinched between the housings, and place the top housing onto the ventilator base assembly, lining up the case halves. Ensure the inspiratory block is properly seated in the lower and upper housings, and that the inlet air filter is properly positioned in its slot.

Caution

When reassembling the upper housing, avoid damage to the flex circuit by routing it inside the Buzzer PCBA and inspiratory block.

3. Hold the housings together and turn the ventilator bottom side up and install the 5 screws. Do not over-tighten.

To replace the upper housing:

When replacing the upper housing, you must also install a new keypad and pneumatic diagram label if your housing did not come with these parts pre-assembled. Use the old housing as a reference for the label location (place label on curved surface on inside of upper housing).

1. To install the pneumatic diagram label, clean the inside housing label surface with isopropyl alcohol using a lint-free wipe, then peel off the adhesive backing and position the label on the new housing.
2. Follow the steps in Section 5.7.8 to install the keypad, then reassemble the upper housing according to the instructions above.

5.7.7 Carrying Handle Removal and Replacement

To remove the carrying handle:

1. Unscrew the two screws on the inside of the upper housing using a T20 Torx® driver.
2. Turn the upper housing over and remove the handle.

To replace the carrying handle:

1. Place the handle in position on the upper housing.
2. While holding the handle in place, turn the upper housing right side down. Using a T20 Torx® driver, fasten the two screws previously removed. Do not over-tighten.

5.7.8 Keypad Removal and Replacement

Caution

To prevent possible damage, do not fold or crease the flex circuit.

To remove the keypad:

1. Slide a small flat-blade screwdriver or other flat tool under one edge of the keypad and gently lift to break the adhesive bond with the upper housing.
2. Lift the keypad away from the housing.
3. Clean the housing with alcohol to remove any adhesive residue.

To replace the keypad:

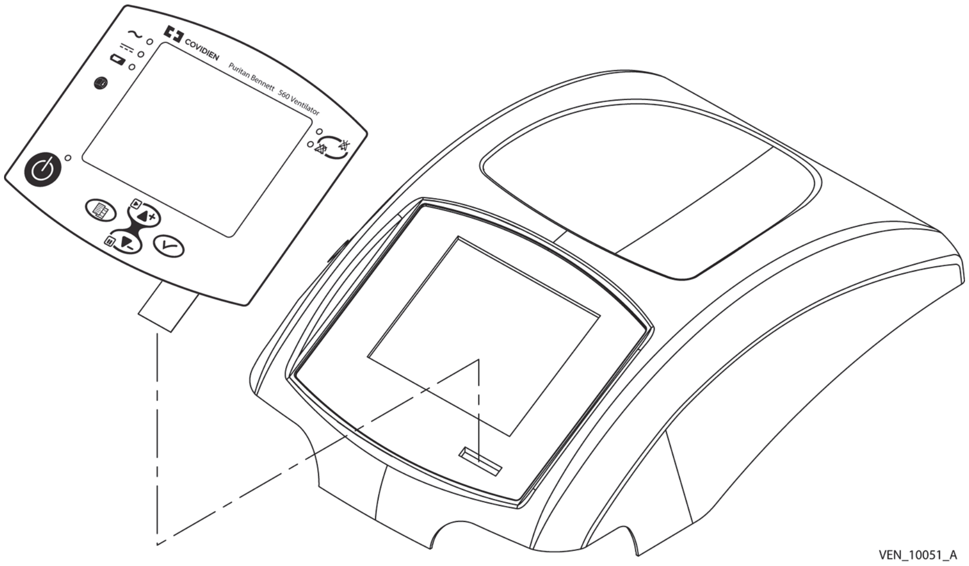
1. Ensure the window does not have finger prints or dust prior to assembly. If necessary, remove protective film from window.
2. Peel away the protective paper backing from the new keypad to expose the adhesive. Use care during handling to ensure no fingerprints or contaminants are deposited on the adhesive surface of the keypad.
3. Route the flex circuit through the slot in the upper housing (Figure 5-12).

4. Align the keypad within the recess in the upper housing and press into place. Use care when re-installing the upper housing so the flex circuit is not pinched.

Caution

Use care when installing the keypad, as any attempt to reposition it can damage the keys.

Figure 5-12. Replacing the Keypad



5.7.9 Exhalation Solenoid Valve Removal and Replacement

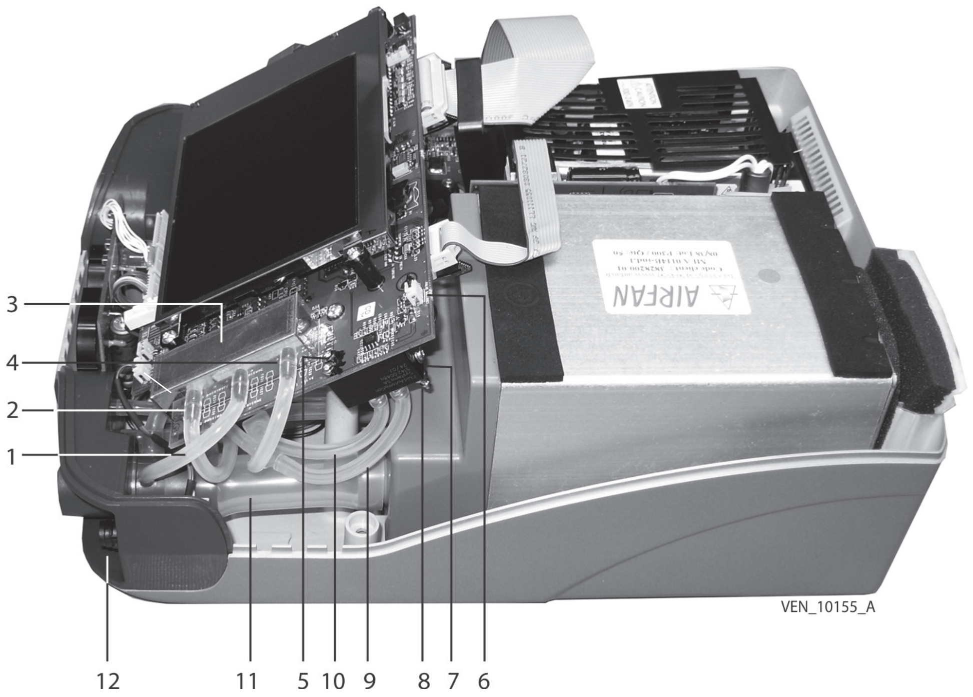
The exhalation solenoid valve is mounted to the CPU PCBA and can be removed without removing the PCBA from the ventilator.

To remove the exhalation solenoid valve:

Refer to Figure 5-13 and do the following:

1. Disconnect the exhalation solenoid valve electrical cable from the CPU PCBA connector (J19).
2. Disconnect the two pneumatic tubes from the valve.
3. Remove the two screws that fasten the solenoid valve to the CPU PCBA using a T9 Torx® driver.

Figure 5-13. Pneumatic Tubing Connections (top view)



1	From inspiratory block port
2	From inspiratory block proximal pressure port
3	Pressure sensors
4	Connects with tee to exhalation valve pilot pressure port
5	Solenoid valve mounting screws
6	Exhalation solenoid valve connector J19
7	Exhalation solenoid valve
8	Do not connect
9	Connects with tee to exh. valve pilot pressure port and valve pressure sensor
10	From turbine
11	Inspiratory gas from turbine
12	FiO_2 connector

To replace the exhalation solenoid valve:

1. Fasten the valve to the CPU PCBA with the two screws previously removed using a T9 Torx® driver. Do not over-tighten.
2. Connect the pneumatic tubes to the valve ensuring correct placement as shown in Figure 5-13. The tube from the turbine connects to the valve "IN" port (from turbine) and the tube to the inspiratory block exhalation valve port connects to the valve "OUT" port (to inspiratory block). Do not connect any tube to the barbed fitting closest to the upper edge of the PCBA (the "IN" and "OUT" ports are silk-screened on the CPU PCBA (Figure 5-16).

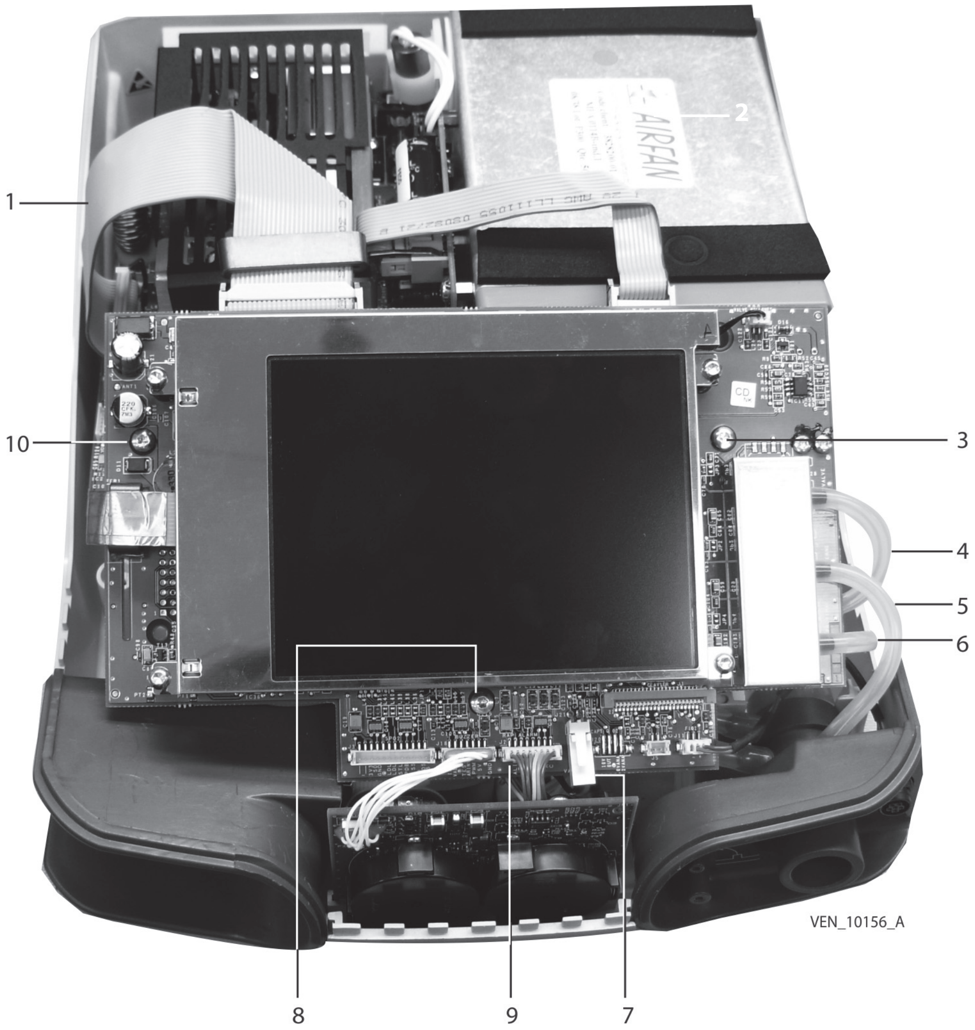
3. Connect the valve's electrical cable to CPU PCBA connector (J19).

5.7.10 CPU PCBA Removal and Replacement

To remove the CPU PCBA:

1. Disconnect the following cables and pneumatic tubes from the CPU PCBA:
   - power management PCBA cable (J7)
   - turbine control PCBA cable (J4)
   - exhalation valve pressure sensor tube (1 VALVE)
   - inspiratory pressure sensor tube (2 INTERNE)
   - proximal pressure sensor tube (3 PROXIMALE)
   - O_2 valve cable (VALVE O_2)
   - remote alarm cable (J2)
   - alarm cable (J18).

Figure 5-14. CPU PCBA Cables and Tubes (top view)

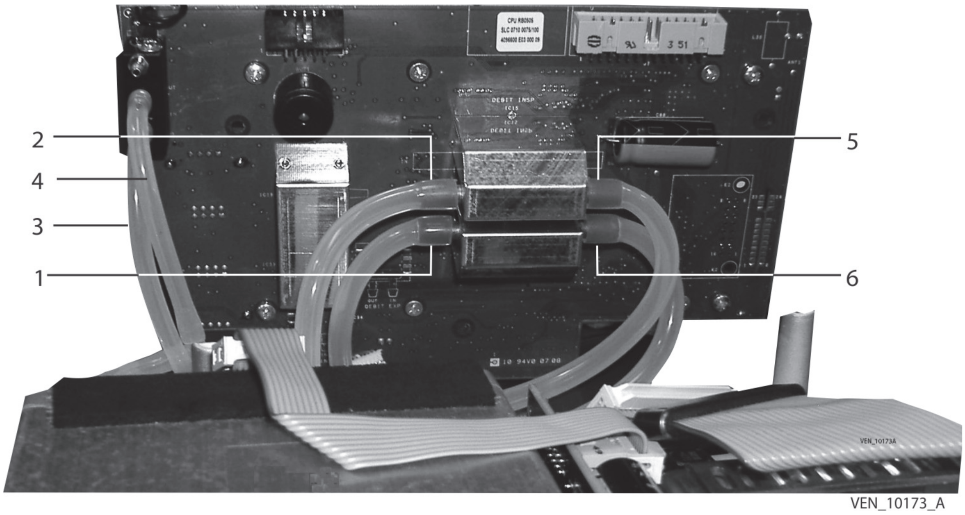


1	Power management cable	**6**	Prox. pressure tube
2	Turbine control PCBA cable	**7**	O_2 valve cable
3	PCBA mounting screw	**8**	PCBA mounting screw
4	Exh. valve pilot pressure tube	**9**	Remote alarm cable
5	Insp. pressure tube	**10**	PCBA mounting screw

2. Remove the three CPU PCBA mounting screws using a T10 Torx® screwdriver and turn the PCBA over to disconnect the following pneumatic tubes from the sensors on the PCBA:
    - inspiratory flow sensor (IN) and (OUT) tubes
    - exhalation flow sensor (IN) and (OUT) tubes
    - exhalation solenoid valve (IN) and (OUT) tubes.

Note:
Observe tube routing to ensure tubes are not kinked or pinched upon reassembly.

Figure 5-15. CPU PCBA Tubing Connections (underside view)



1	Exh flow sensor (OUT)	**4**	Exh solenoid valve (OUT)
2	Insp flow sensor (IN)	**5**	Insp flow sensor (OUT)
3	Exh solenoid valve (IN)	**6**	Exh flow sensor (IN)

To remove the turbine tube assembly:

1. Gently pull the tube from the turbine and inspiratory block connectors.

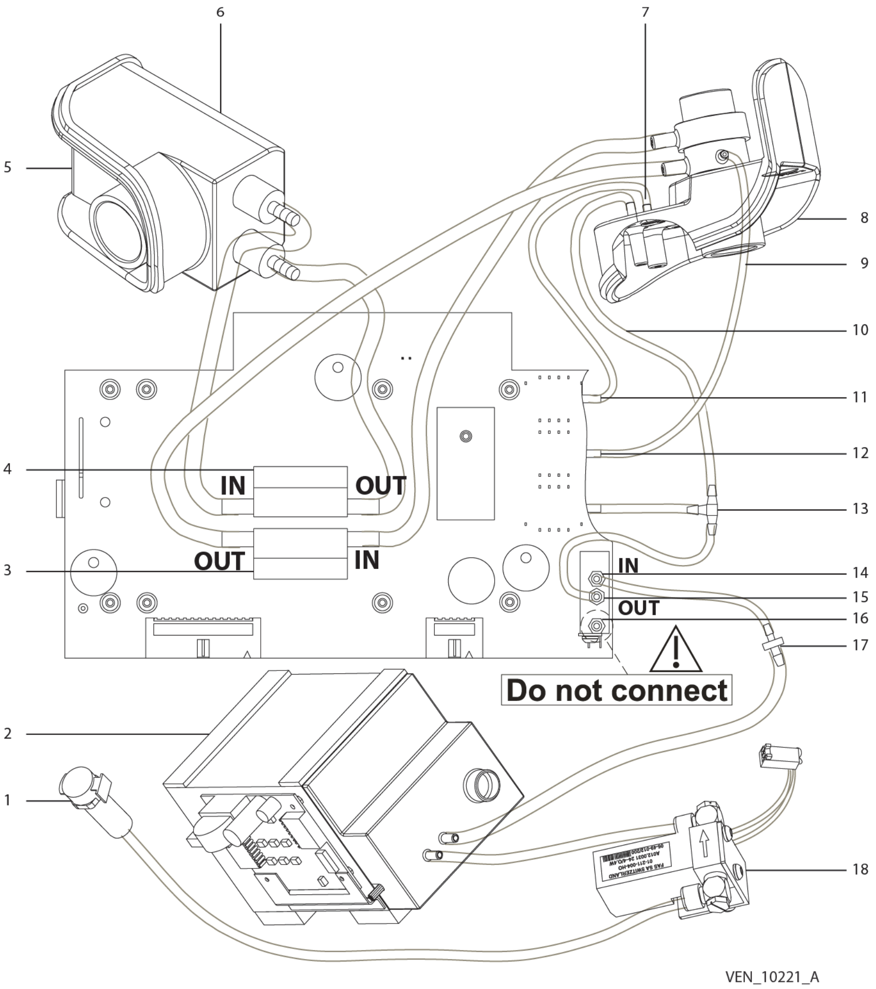
To replace the turbine tube assembly:

1. Push the tube onto the inspiratory block and turbine connectors, as shown in Figure 5-21. Ensure the tube is inserted fully on the connectors.

To replace the CPU PCBA:

1. Reconnect the pneumatic tubing to the flow sensors and exhalation solenoid valve on the underside of the CPU PCBA according to the diagram shown in (Figure 5-16). Refer to Section 7.4 for tubing lengths and diameters.

Figure 5-16. Pneumatic Tubing Diagram


6
7
5
8
9
10
11
12
4
IN
OUT
13
3
OUT
IN
IN
14
15
OUT
16
17
Do not connect
2
1
18
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1	O_2 connector (rear of ventilator)	**10**	To exh valve port on insp block
2	Turbine	**11**	Proximal pressure sensor (PROXIMALE)
3	Insp flow sensor	**12**	Inspiratory pressure sensor (INTERNE)
4	Exh flow sensor	**13**	Exh pressure sensor (VALVE)
5	Exhalation block	**14**	Exh solenoid valve (IN)
6	Exhalation conical fitting support	**15**	Exh solenoid valve (OUT)
7	To prox port on insp block	**16**	Do not connect
8	Insp block	**17**	See Note in step 3 below
9	To insp pressure port on insp block	**18**	O_2 solenoid valve

2. Place the CPU PCBA on the standoffs and install 3 mounting screws using a T10 Torx® screwdriver. Ensure the tubing is routed underneath the PCBA so that it is not kinked or pinched.
3. Connect the tubing to the pressure sensor ports on top of the CPU PCBA according to the diagram shown in Figure 5-16.

Note:
Ensure the wider end of the straight connector is attached to the larger diameter tube and that the narrower end of the connector is attached to the smaller diameter tube. See Table 7-4 for part numbers. The tubes must be fully seated to the connector.

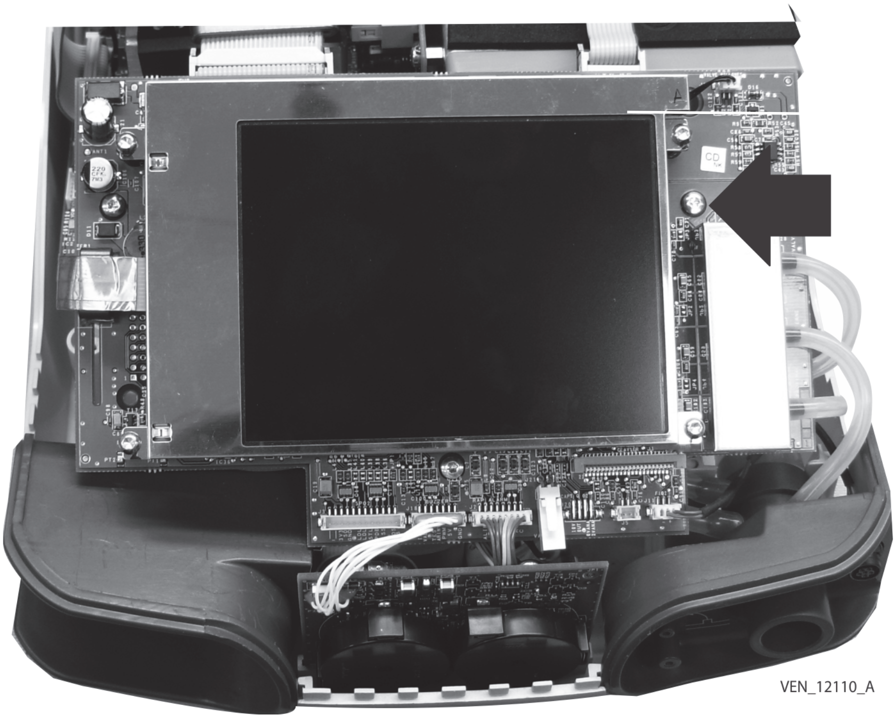
4. Make the following cable connections:
   - power management PCBA cable (J7)
   - turbine control PCBA cable (J4)
   - O_2 valve cable (VALVE O_2)
   - remote alarm cable (J2)
   - alarm cable (J18)

5.7.11 LCD Panel Removal and Replacement

To remove the LCD panel:

1. Using a T10 Torx® screwdriver, remove the four screws that fasten the LCD panel to the CPU PCBA.

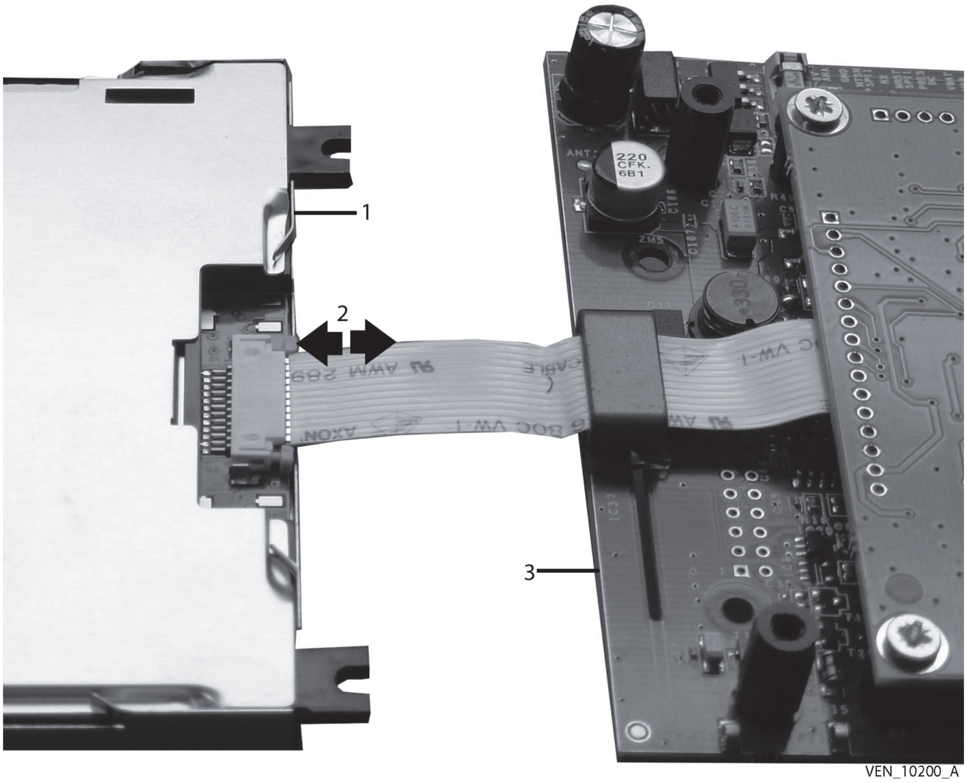
Figure 5-17. Removing the LCD Panel



LCD panel mounting screws (4 pl)

2. Gently lift the LCD panel away from the PCBA and lay it bottom side up on the work surface, being careful not to pull or damage the flex circuit.
3. Release the locking tabs on the LCD panel connector and slide the flex circuit away from the panel.

Figure 5-18. LCD Flex Circuit Detail



1 LCD panel
2 Pull connector tabs outward to unlock flex circuit, push inward to lock
3 CPU PCBA

To replace the LCD panel:

1. Slide the flex circuit into the unlocked connector on the LCD panel and push the tabs inward to lock the circuit in place.
2. Turn the LCD panel over and mount to the standoffs on the CPU PCBA using four screws previously removed.
3. Peel back the protective cover from the LCD panel.

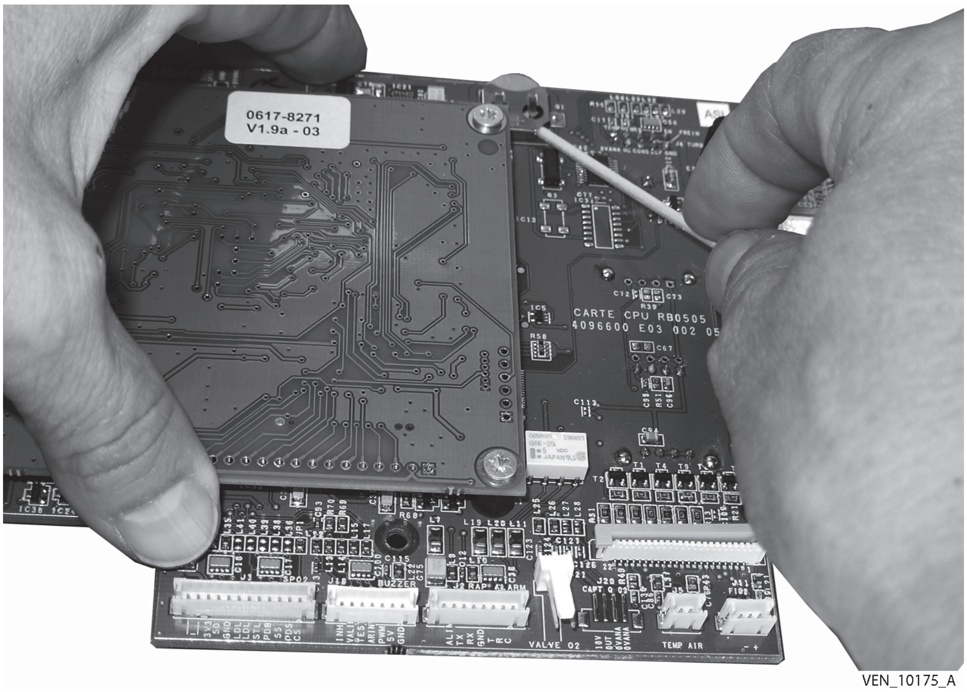
5.7.12 3 V Battery Removal and Replacement

The 3 V battery is located on the CPU PCBA under the LCD panel (G1).

To remove the 3 V battery from the CPU PCBA:

Avoid causing a short-circuit by using a small wood or plastic tool (the bare end of a cotton swab is shown in Figure 5-19) to push the battery out of its retainer on the CPU PCBA.

Figure 5-19. Removing the 3V Battery (LCD panel removed)



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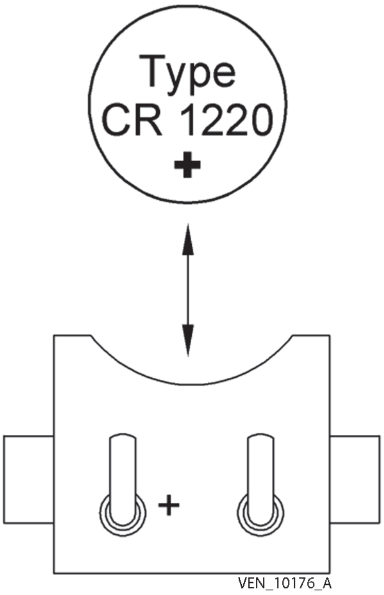
To replace the 3 V battery on the CPU PCBA:

Slide the new battery into the retainer (G1), making sure that the positive side of the battery is facing upward (Figure 5-20).

Note:

Verify time and date are correct after replacing battery.

Figure 5-20. Replacing the 3 V Battery



5.7.13 Inspiratory Block Removal, Cleaning and Replacement

To remove the inspiratory block:

1. Detach the large tube connecting the inspiratory block (if not already removed) to the turbine assembly.
2. Remove the inspiratory block and connected pneumatic tubes from the ventilator lower housing.

To clean the inspiratory block:

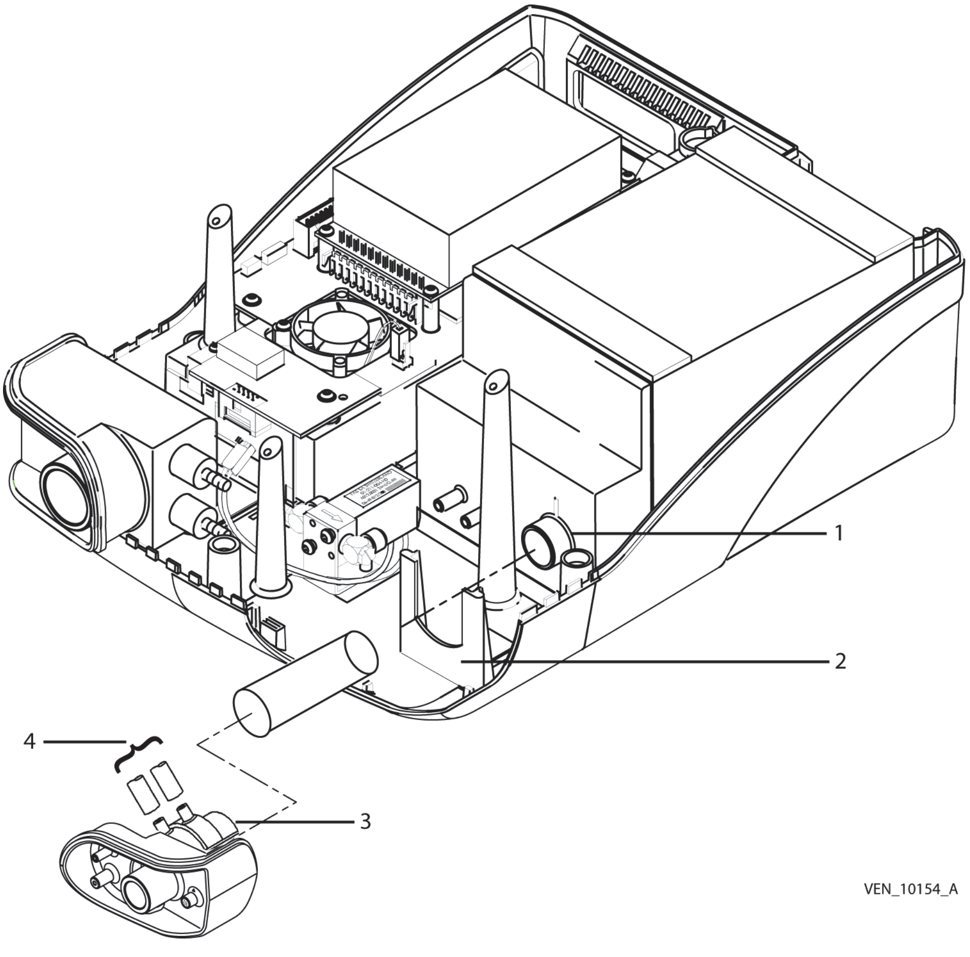
1. Remove the pneumatic tubes from the assembly and replace if dirty. Inspect the inspiratory block for signs of occlusion or damage. Replace if necessary.
2. Dampen a soft cloth with a cleaning solution (see Table 2-14 for a list of approved cleaners and disinfectants) and wipe the inspiratory block thoroughly.
3. Ensure the inspiratory block is completely dry and in good condition before reinstalling into the ventilator.

To replace the inspiratory block:

1. Replace pneumatic tubes prior to installing the inspiratory block (Figure 5-16). See Section 7.4 for tubing part numbers and a detailed assembly drawing.
2. Push the large tube onto the turbine outlet fitting, making sure that the inspiratory block fitting rests on the support bracket.

Note:
Perform inspiratory flow sensor calibration after cleaning or replacing inspiratory block.

Figure 5-21. Installing the Inspiratory Block



1	Turbine outlet fitting
2	Support bracket
3	Inspiratory block fitting
4	Not all tubes shown

5.7.14 FiO_2 Connector and Cable Removal and Replacement

To remove the FiO_2 connector and cable:

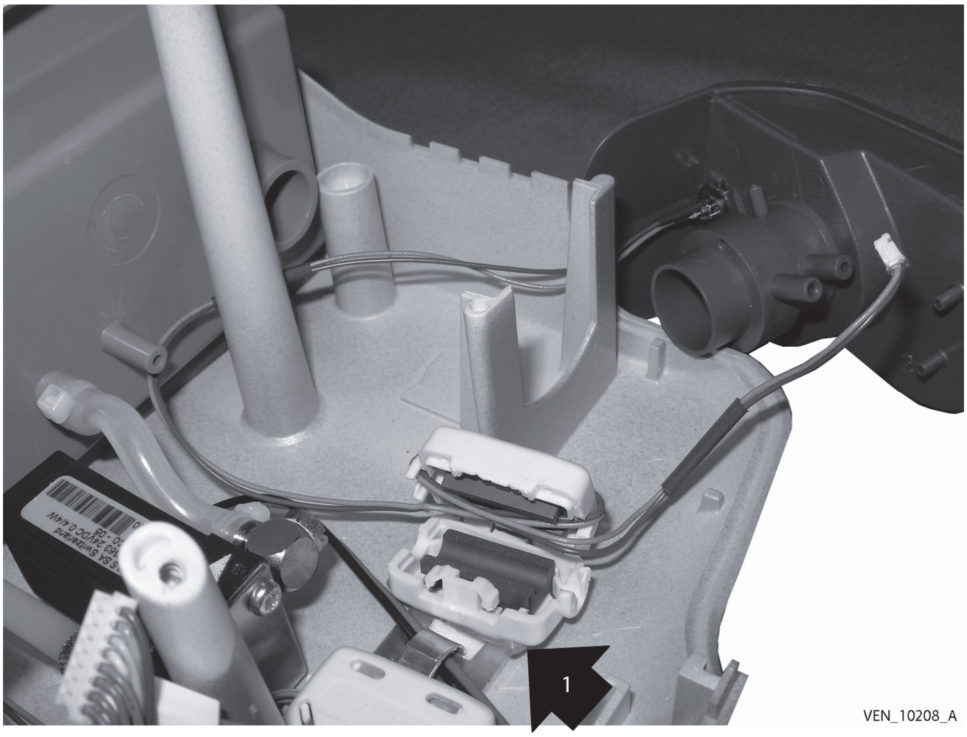
The FiO_2 cable must be replaced together with the connector, as it is soldered in place.

1. If not already disconnected, disconnect the FiO_2 cable connector from (J11 FiO_2) on the CPU PCBA.
2. Remove the 10-mm hex nut holding the cable assembly to the inspiratory block, and slide the nut away from the connector.
3. Pull the ferrite away from the double-sided tape securing it to the lower housing.
4. Open the ferrite using a flat-bladed screwdriver and remove the cable assembly.
5. Remove the FiO_2 cable from the ferrite, and retain the 10 mm hex nut for reassembly, or use a new one if supplied with the connector.
6. Remove the FiO_2 Cable and Connector from the Inspiratory Block.

To replace the FiO_2 connector and cable:

1. If installed, remove the 10-mm hex nut (and lock washer if present) from the FiO_2 connector/cable assembly.
2. Route the cable wires through the inspiratory block and install the 10 mm hex nut to hold the connector in place in the inspiratory block. Tighten hand-tight. The lock washer is not used during re-assembly.
3. Orient the arrow on the connector so it points toward the lung symbol on the inspiratory block label (straight up).
4. Tighten the 10-mm hex nut to secure the connector. Do not over-tighten.
5. Route the cable wires as shown in Figure 5-22, ensuring the wires are routed around the rear of the PCBA mounting post and are not inside the turbine tubing support area.
6. Ensure the PCBA connector exits the ferrite toward the front of the ventilator.
7. Close the ferrite, ensuring the cable is not pinched.
8. Replace the double-sided tape to ensure good adhesion and secure the ferrite to the tape (see Table 7-3 for tape part number). Tape and ferrite should be placed next to cable guide 3 (Figure 5-22).
9. Re-connect FiO_2 cable to (J 11 FiO_2) on CPU PCBA after reassembling internal components.

Figure 5-22. FiO_2 Cable Routing and Tape Placement



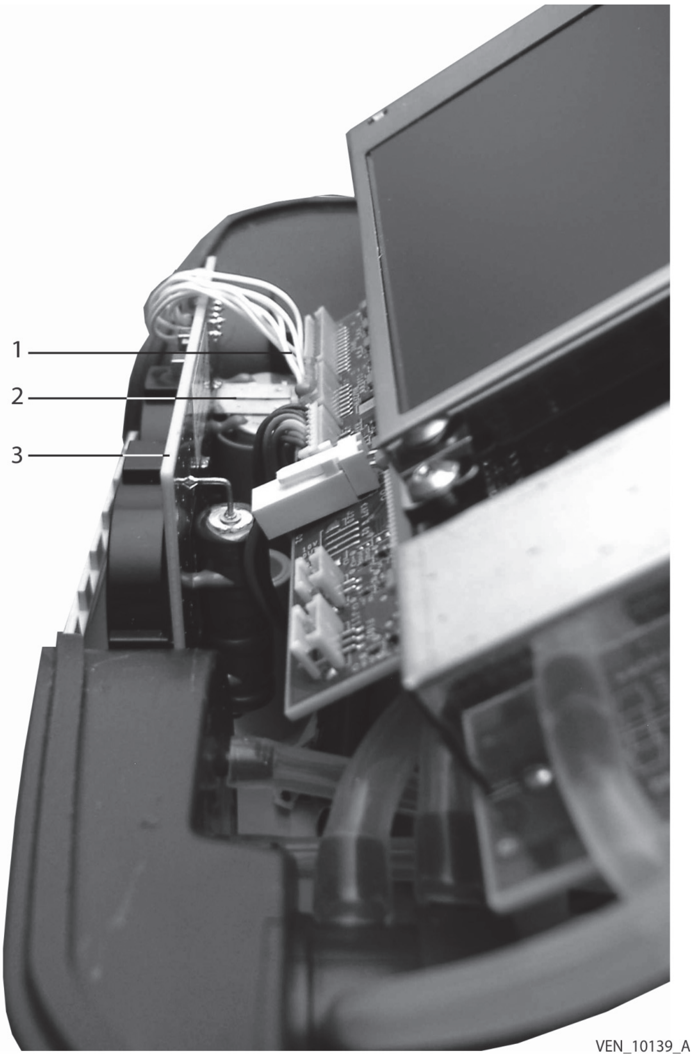
1	Double sided tape

5.7.15 Buzzer PCBA Removal and Replacement

To remove the buzzer PCBA:

1. If not already disconnected, remove buzzer PCBA connector from J18 on the CPU PCBA.
2. Slide the PCBA upward out of its slot in the lower housing.

Figure 5-23. Buzzer PCBA and Cable Detail



1 Buzzer PCBA connector J 18

2 Buzzer battery

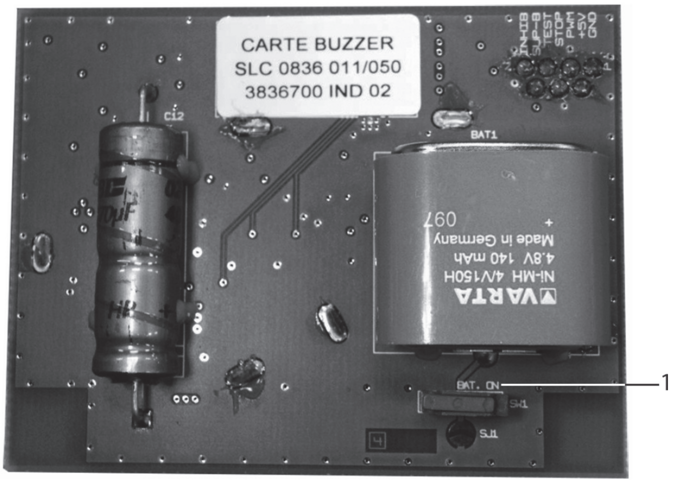
3 Buzzer PCBA

To replace the buzzer PCBA:

Note:

To ensure the buzzer PCBA switch is set properly, slide the switch to the left (Figure 5-24).

Figure 5-24. Buzzer PCBA Switch (underside shown)



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1 Slide switch to the left

1. Insert the PCBA into its slot in the lower housing. Ensure the PCBA seats fully into the slot.
2. Re-connect the connector at J18 on the CPU PCBA.

5.7.16 Exhalation Conical Fitting Removal and Replacement

Note:

The exhalation block may remain in the conical fitting during this procedure and the assembly may be removed as a unit.

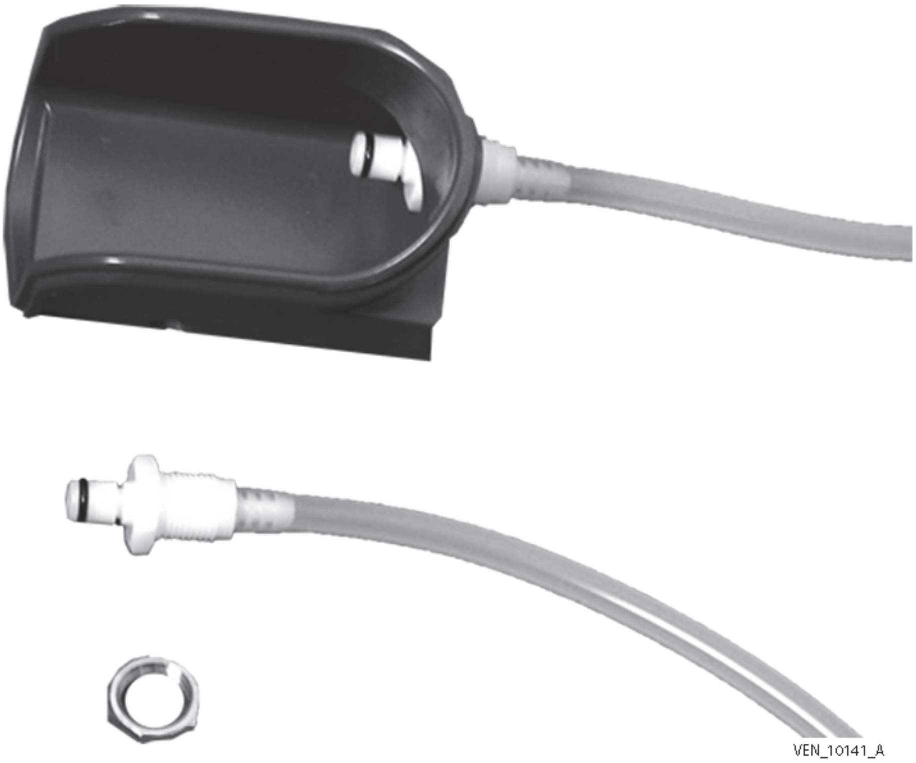
To remove the exhalation conical fitting:

1. Tilt the ventilator upward and unscrew the captive knob holding the exhalation block and housing in place.
2. Remove the cover from the ventilator.
3. Lift the exhalation conical fitting and connected pneumatic tubes out of the lower housing.
4. Inspect the pneumatic tubing and exhalation connectors. If dirty, remove the lock nuts fastening the connectors using a 16-mm wrench and socket. If necessary, replace pneumatic tubes and tubing connectors. If the connectors and pneumatic tubes are clean, remove them and set aside for reassembly.

To replace the exhalation conical fitting:

1. Install new tubing connectors (if necessary) into the new exhalation conical fitting using the lock nuts previously removed. Ensure the tubing connectors seat properly into the hex-shaped recesses in the inside of the exhalation conical fitting (Figure 5-25). Do not over-tighten.

Figure 5-25. Exhalation Conical Fitting and Baffle Conduit Fittings



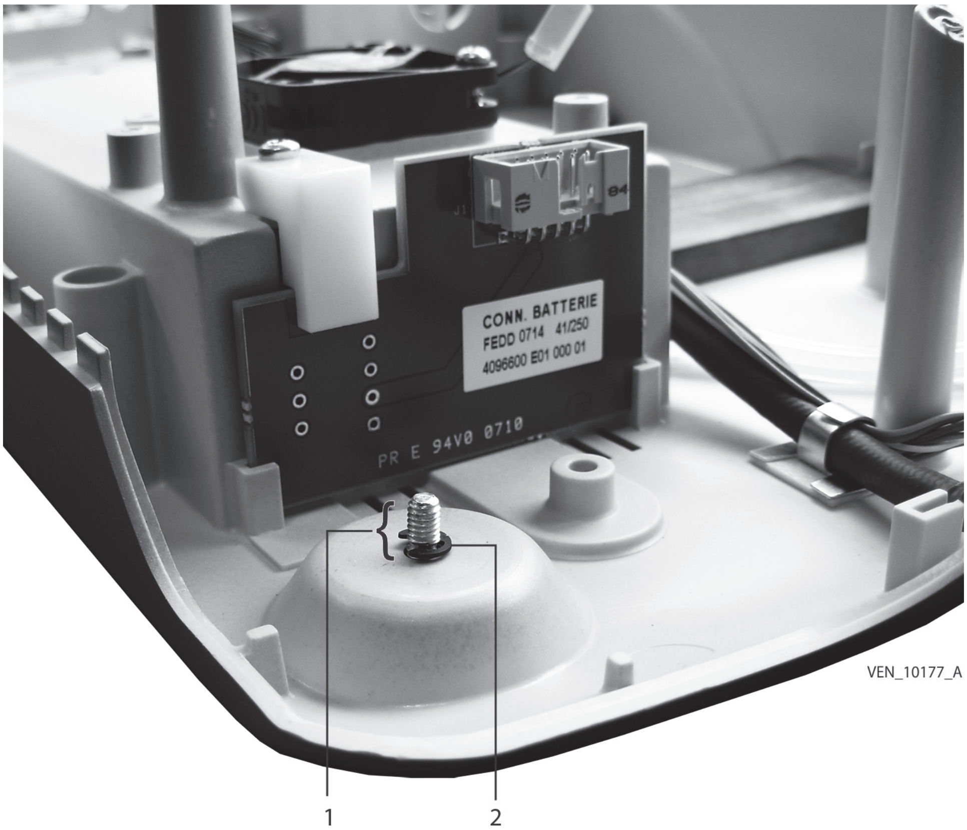
2. Replace pneumatic tubes (if necessary) prior to installing the exhalation conical fitting (Figure 5-16). See Section 7.4 for part numbers and a detailed assembly drawing.
3. Place the exhalation conical fitting into the lower housing and hand-tighten the captive knob to hold it in place.
4. Route the pneumatic tubes in front of the CPU PCBA mounting standoff.

5.7.17 Captive Knob Removal and Replacement

To remove the captive knob:

Using needle-nose pliers, pull the e-clip away from the threaded portion of the captive knob and remove the knob from the bottom of the lower housing.

Figure 5-26. E-clip Detail



1 Approx. 1/4-in or 8 threads

2 Pull e-clip with pliers to remove

To replace the captive knob:

1. Push the threaded end of the knob through the opening in the lower housing, and rest the housing on the work surface right side up.
2. Install the e-clip so that it is flush with the surface of the lower housing (Figure 5-26). There should be approximately 1/4 inch (6mm) or 8 threads protruding above the housing surface.

5.7.18 Oxygen Solenoid Valve Removal and Replacement

Refer to Figure 5-27 for oxygen solenoid valve removal and replacement.

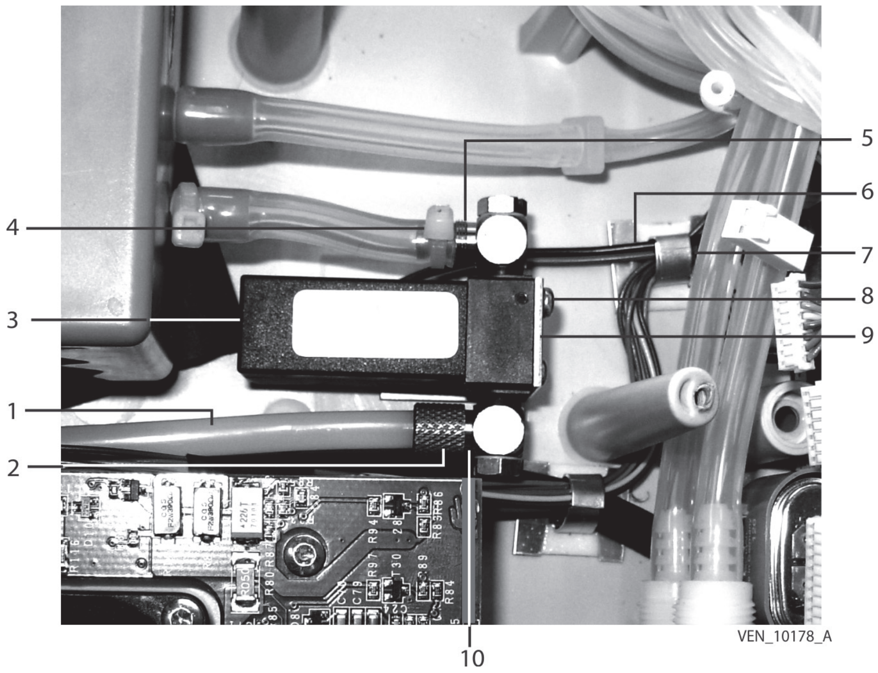
To remove the oxygen solenoid valve:

1. Cut the tie wrap and disconnect the silicone pneumatic tubing from the valve outlet fitting. Be careful not to cut the tubing.
2. Open the tabs on the cable guide 3 (Figure 5-35) to release the oxygen solenoid valve harness.
3. Remove the screws that hold the valve to its mounting bracket using a T9 Torx® driver.
4. Lift the valve assembly up, unscrew the knurled retainer ring, and pull the oxygen tubing from the barbed inlet fitting. A small flat-bladed screwdriver may be useful for loosening the tubing from the fitting.

Note:

If you need to replace the oxygen inlet tube and connector, you will have to remove the turbine assembly and power management PCBA first (see Section 5.7.19 and Section 5.7.22).

Figure 5-27. Oxygen Valve Detail



1	Oxygen tubing	**6**	Valve wiring harness
2	Knurled retaining ring	**7**	Cable guide
3	Oxygen valve	**8**	Mounting screw
4	Tie wrap	**9**	Valve mounting bracket
5	Valve outlet	**10**	Valve inlet

To replace the oxygen solenoid valve:

1. Fasten the new oxygen solenoid valve to the mounting bracket using the two screws previously removed.
2. Connect the oxygen tubing to the valve inlet fitting, and tighten the knurled retainer ring.

WARNING

Ensure the oxygen tubing is connected tightly to the inlet fitting to prevent oxygen from leaking into the ventilator compartment.

---

3. Place the oxygen solenoid valve/bracket assembly into the lower housing and fasten in place with the two screws previously removed. Ensure the wiring harness is not caught underneath the mounting bracket.
4. Connect the silicone tube from the turbine assembly to the valve outlet fitting and fasten with a tie wrap using a tie wrap gun to ensure a tight grip on the tubing.
5. Route the valve's wiring harness through cable guide 3 and bend the tabs closed.

To test the connections for leaks:

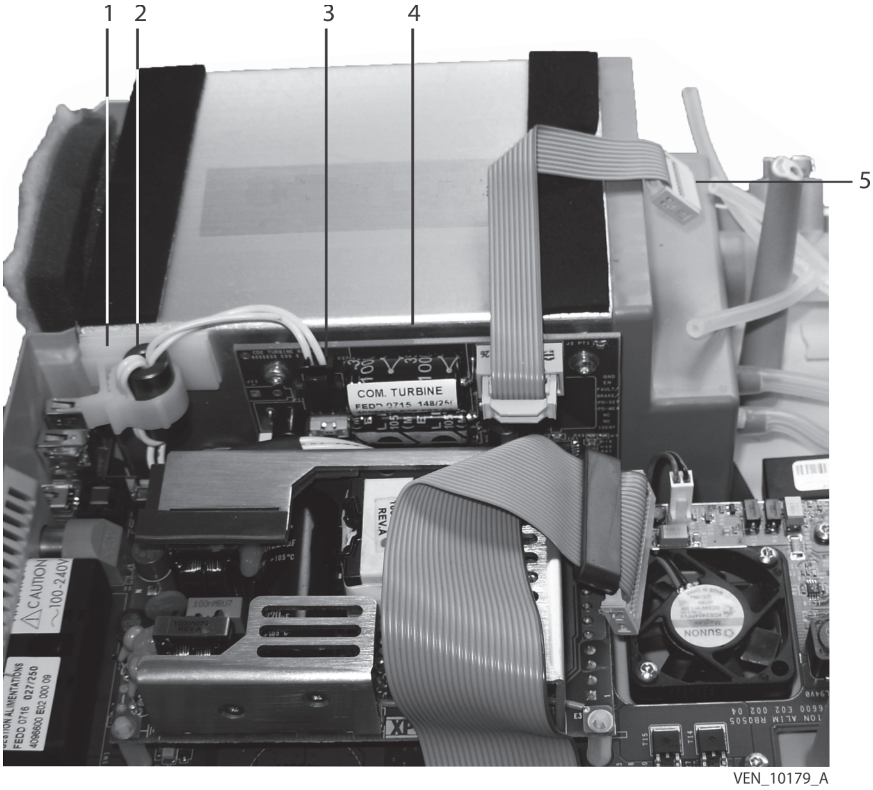
1. Connect an O_2 supply to the O_2 inlet connector at the rear of the ventilator. Adjust the source pressure to less than 7 psi or flow less than15 lpm.
2. Apply leak detector solution to each end of the tube where it connects with the oxygen inlet fitting at the rear of the ventilator and the oxygen solenoid valve inlet, and to the tube connecting the oxygen solenoid valve outlet to the turbine.
    - Verify no bubbles form at the connections
    - If a leak is detected, tighten connection and repeat test until no leaks are found
3. Wipe any remaining leak detector solution from the connections.

5.7.19 Turbine Assembly Removal and Replacement

To remove the turbine assembly:

1. Disconnect the power management/turbine control cable from the turbine control PCBA connector (J1) by pushing in the tab and pulling the connector.

Figure 5-28. Power Management/turbine Control Cable Detail



1	Cable clamp	**4**	Turbine control PCBA
2	Toroid	**5**	Connector to CPU PCBA (J 4)
3	Connector J 1		

2. Open the cable clamp and remove the toroid and cable.
3. Cut the tie-wrap that secures the tube connected to the oxygen solenoid valve, and remove the tube from the turbine. Be careful not to cut the tube.
4. Disconnect the large tube from the turbine outlet and inspiratory block.
5. Disconnect the tube between the turbine and the exhalation solenoid valve.
6. Lift the turbine assembly out of the housing.

To replace the turbine assembly:

1. Position the turbine assembly so that it rests on the foam pads in the lower housing.
2. Attach the tube connected to the oxygen solenoid valve to the turbine with a tie-wrap as shown in Figure 5-28. Tighten the tie-wrap with a tie-wrap applicator gun.

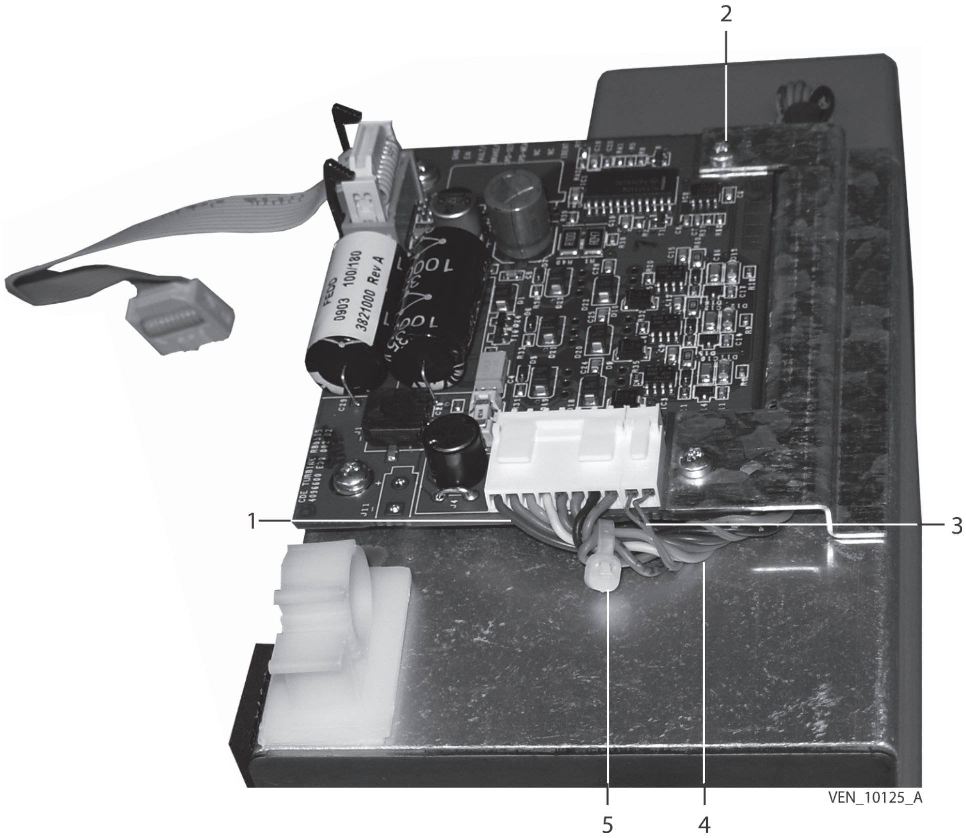
3. Connect the tube between the exhalation solenoid valve and the turbine.
4. Connect the large silicone tube between the turbine outlet and inspiratory block.
5. Route the toroid/cable through the cable clamp and close the clamp tightly around the toroid as shown in Figure 5-28.
6. Connect the cable to connector J1 on the Turbine Control PCBA.

5.7.20 Turbine Control PCBA Removal and Replacement

To remove the Turbine Control PCBA:

1. Disconnect the motor and temperature sensor cables from the Turbine Control PCBA connector (J6) (Figure 5-29).
2. Open the cable clamp and remove the toroid and cable.
3. Remove the four screws fastening the PCBA and mounting bracket to the turbine housing, using a T10 Torx® driver.
4. Lift the PCBA and bracket from the turbine assembly.
5. Disconnect the toroid/cable assembly from the PCBA by pushing in the tab on the connector at J1 and pulling the connector out of the PCBA. This harness should remain connected to the Power Management PCBA.

Figure 5-29. Turbine Control PCBA



1 Motor cable (J 6)

2 Mounting screw (4 pl)

3 Temp sensor cable

4 Do not pinch cables when reinstalling bracket

5 Tie wrap; Do not use tie wrap gun to tighten

To replace the Turbine Control PCBA:

1. Place the Turbine control PCBA on the turbine assembly standoffs aligning the holes in the PCBA with the standoffs.
2. Place the bracket over the PCBA, and route the cables under the bracket as shown in Figure 5-29. Make sure that the bracket captures the two cable assemblies, but does not pinch them against the turbine assembly body.
3. Evenly tighten the screws using a T10 Torx® driver. Do not over-tighten.
4. Connect the motor cable and temperature sensor cables as shown in Figure 5-29 to connector J6 on the PCBA.
5. Place a tie-wrap around the harnesses as shown in Figure 5-29 and hand-tighten.Do not tighten the tie-wrap with a tie-wrap gun. Cut tail of tie-wrap with cable cutter.

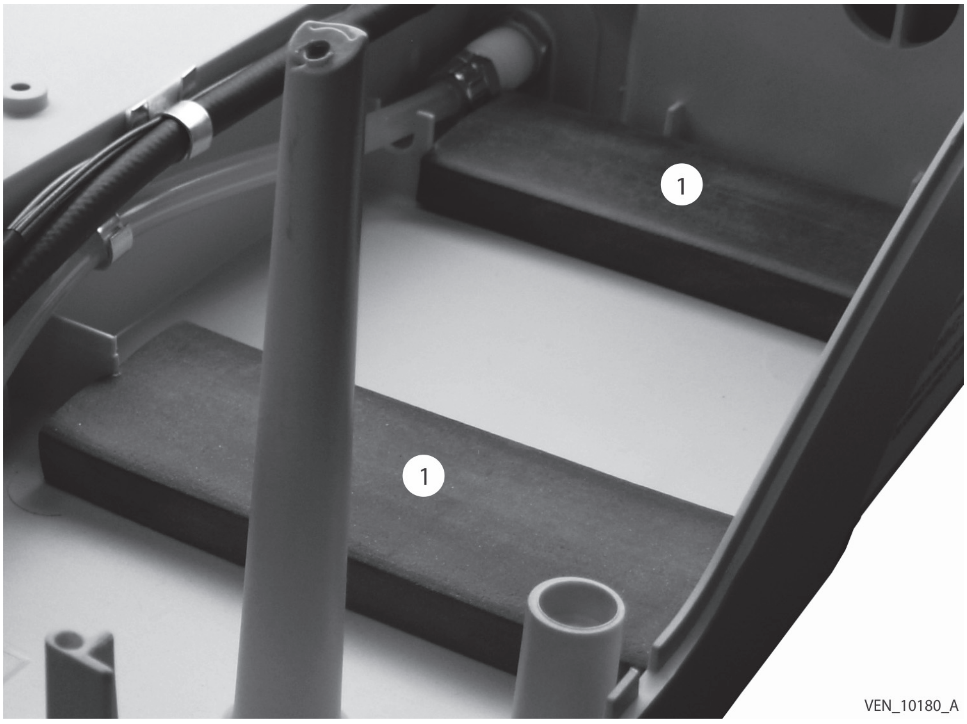
6. If not already assembled, adhere the cable clamp to the corner of the turbine as shown in Figure 5-29.
7. Connect the toroid/cable assembly to J1 on the turbine control PCBA (Figure 5-28).
8. Secure the toroid in the cable clamp as shown in Figure 5-28.

5.7.21 Turbine Foam Pads Removal and Replacement

To remove and replace lower turbine support pads:

Lift the turbine support pads out of the lower housing and replace with new ones. There is no adhesive on these pads.

Figure 5-30. Turbine Support Pad Detail

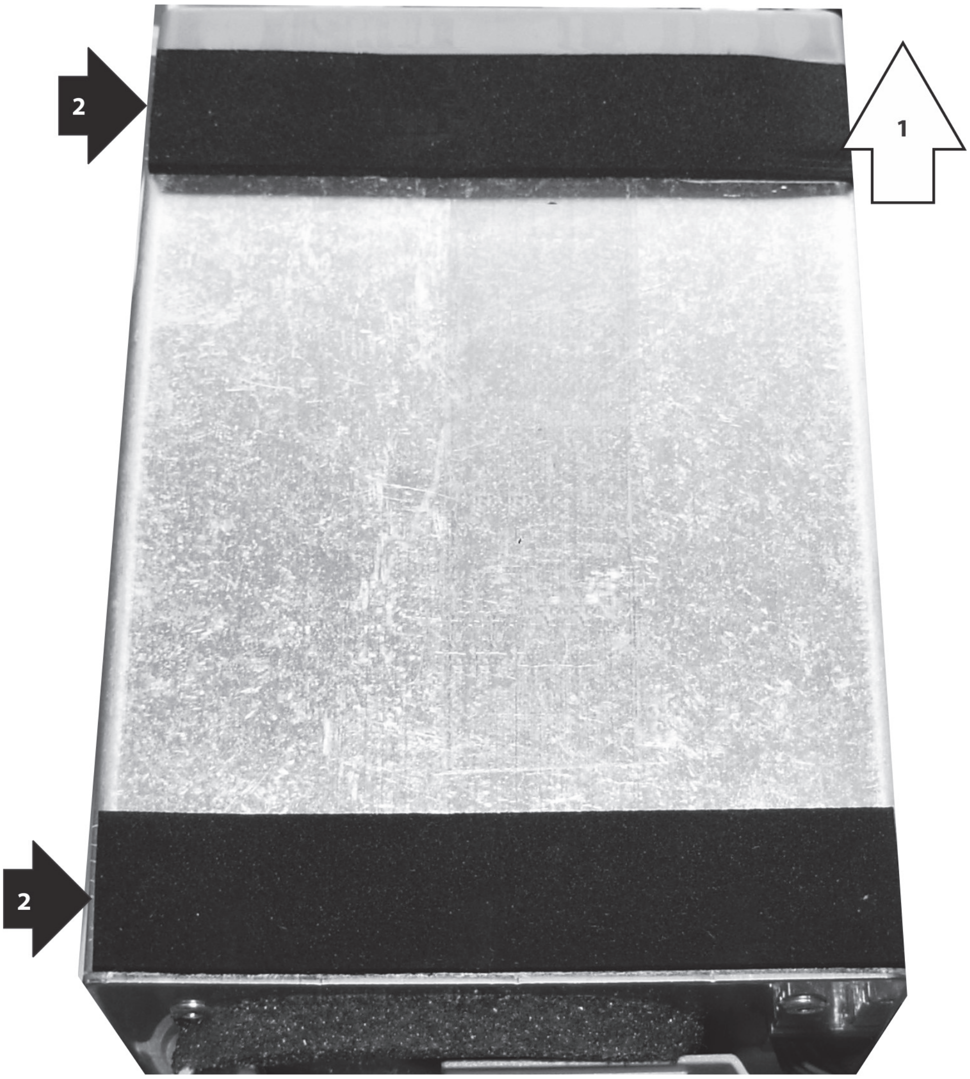


1	Foam pads

To remove the upper turbine pads:

1. Using a flat tool or scraper, remove the pads from the top of the turbine.
2. Clean the residual adhesive from the turbine housing using isopropyl alcohol. Wipe dry.

Figure 5-31. Upper Turbine Pad Detail



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1 Front of ventilator

2 Adhere pads to metal part of turbine housing as shown

To replace the upper turbine pads:

Peel the adhesive backing from the turbine pads and apply to the turbine housing in the positions shown in Figure 5-31.

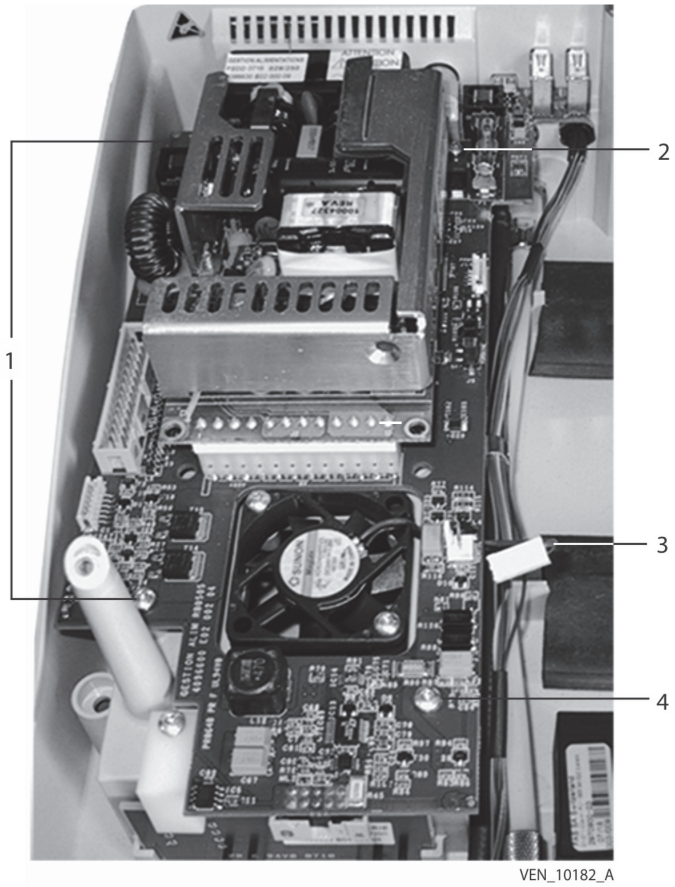
5.7.22 Power Management PCBA Removal and Replacement

The power management PCBA consists of the power management PCBA and the power supply PCBA. The power supply PCBA is mechanically fastened to the power management PCBA via four standoffs.

To remove the power management PCBA:

1. Remove the battery to prevent damage from an accidental short-circuit.
2. Disconnect the fan from the power management PCBA connector (J6).

Figure 5-32. Power Management PCBA Mounting Screw Locations



1	Mounting screws	**3**	Fan cable routed under PCBA prior to connecting
2	Mounting screw	**4**	Mounting screw

3. Remove the four screws fastening the power management PCBA to the lower housing using a T10 Torx® driver (Figure 5-32).

4. Lift the front of the Power Management PCBA to disconnect it from the Battery Connection PCBA, then remove from the ventilator housing taking care not to damage the connectors at the rear of the assembly.

To replace the power management PCBA:

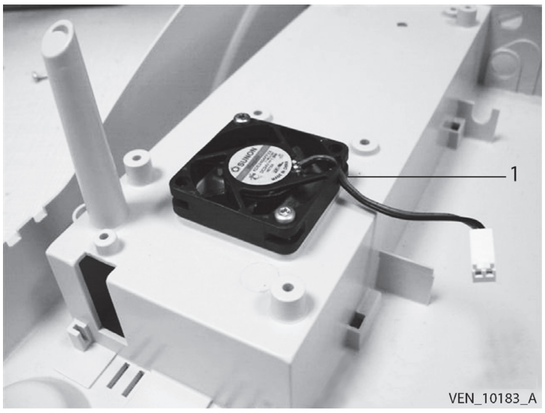
1. Place the power management PCBA onto the standoffs in the lower housing so that the connectors fit through the holes at the rear. Make sure that the connector on the power management PCBA is seated properly into Battery Connection PCBA connector (J1), and that the fan cable is routed underneath the PCBA (Figure 5-32).
2. Fasten the PCBA in place using the four screws previously removed. Do not over-tighten.
3. Connect the fan cable to the PCBA connector (J6).
4. Reinstall battery.

5.7.23 Fan Removal and Replacement

To remove the fan:

1. Remove the two screws fastening the fan to the lower housing using a T10 Torx® driver Figure 5-33.

Figure 5-33. Fan Detail



1	Wires routed through retainer in fan housing

To replace the fan:

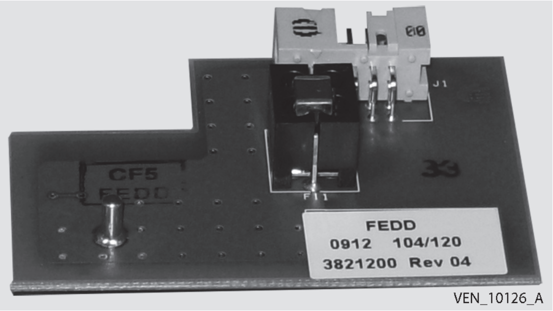
1. Ensure the fan is oriented as shown in Figure 5-33 with air flow pointing UP and route the wiring harness through the retainer on the fan housing.
2. Fasten the fan to the lower housing using two screws placed diagonally as shown in Figure 5-33. Do not over-tighten.

5.7.24 Battery Connection PCBA Removal and Replacement

To remove the battery connection PCBA:

1. Remove the screw fastening the battery connection PCBA stop to the housing using a T10 Torx® driver.
2. Lift the battery connection PCBA out of its slot (Figure 5-34).

Figure 5-34. Battery Connection PCBA



To replace the battery connection PCBA:

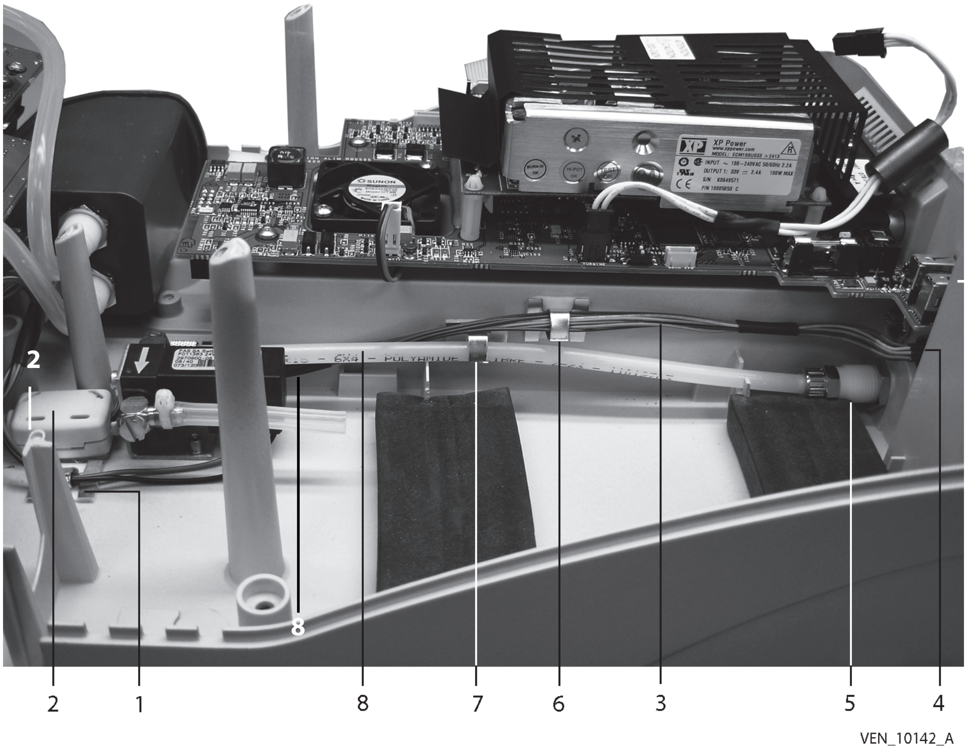
1. Insert the battery connection PCBA into the slot in the lower housing.
2. Install the bracket with the screw previously removed so that it retains the PCBA. Do not over-tighten.

5.7.25 Remote Alarm (Nurse Call) Cable Removal and Replacement

To remove the remote alarm cable:

1. Bend back the tabs on cable guide 1 to release the cable from the lower housing.
2. Remove the connector lock nut from the inside of the lower housing using an 11-mm open-end wrench or needle-nose pliers (Figure 5-35).
3. Remove the cable from the back of the lower housing.

Figure 5-35. Remote Alarm Cable and Oxygen Tubing Assembly



1 Cable guide 3 (for oxygen valve harness)

2 Ferrite

3 Remote alarm harness

4 Remote alarm cable connector

5 Oxygen connector

6 Cable guide 1

7 Cable guide 2

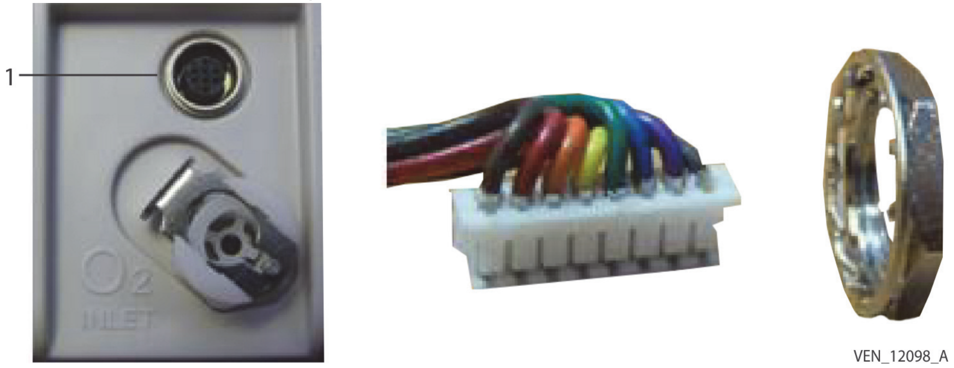
8 Tubing shown disconnected from turbine for clarity

To replace the remote alarm harness

1. Remove nut and washer prior to pushing connector through slot in rear of enclosure. (Figure 5-36)

2. Form cable and connector as shown and push through nut. Be careful not to damage wire during this operation.

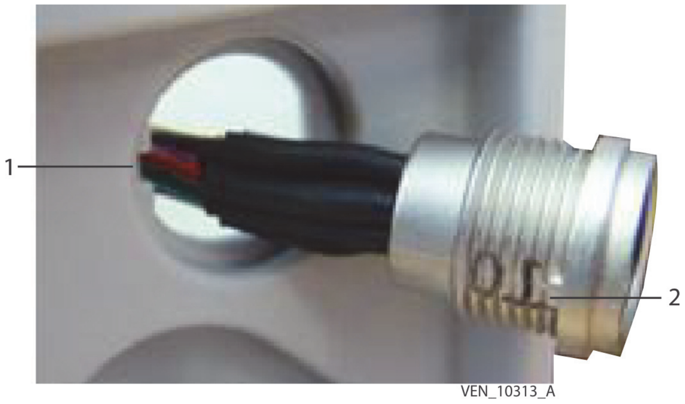
Figure 5-36. Remote Alarm Harness



1 Location for harness

3. Thread washer and nut over connector as shown in (Figure 5-38) and line up the tab with the notch on the housing. (Figure 5-37)
4. Ensure connector socket is orientated so that pin 1 is at the top (Figure 5-38)
5. Hand tighten when connector is correctly aligned. (Figure 5-38)
6. Tighten locking nut (Figure 5-38) using 12mm wrench. Once complete ensure the socket is orientated so that pin 1 is at the top. Do not over-tighten.

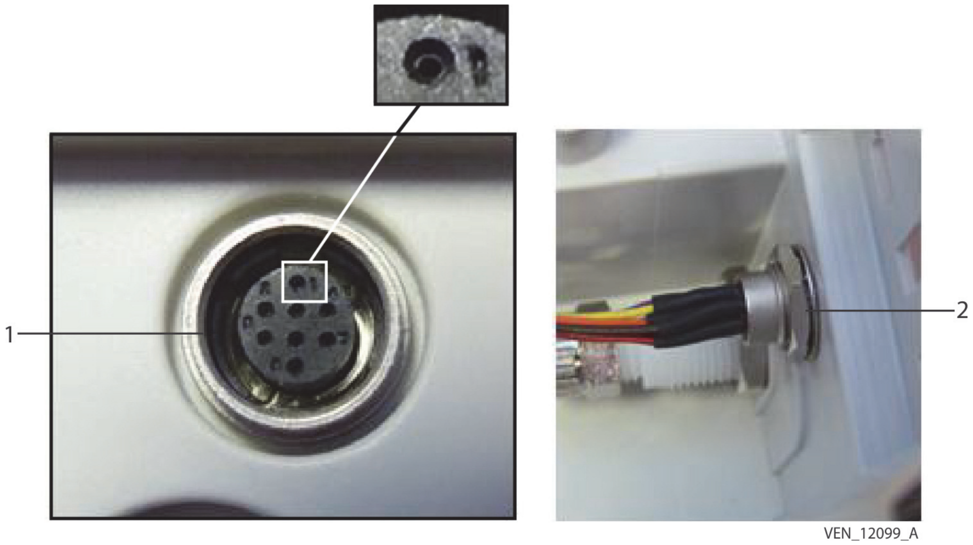
Figure 5-37. Aligning Harness Connector Tab with Housing Notch



1 Notch on housing

2 Tab on harness connector

Figure 5-38. Orientation of the Connector and Tightening Locking Nut



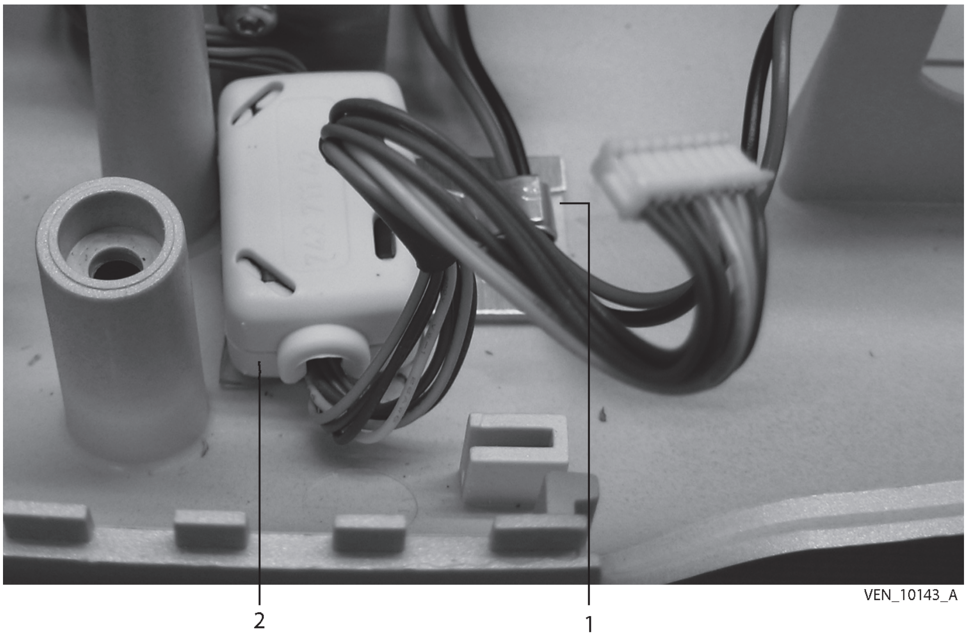
1 Connector

2 Locking nut

7. Route the cable through cable guide 1 (Figure 5-35) and secure it by bending the tabs over the cable.
8. Open the ferrite.
9. Twist remote alarm cable so that it sits inside the ferrite and clamp the ferrite closed (Figure 5-39).

10. Secure ferrite to cable guide 3 with a 25 mm length of double-sided tape (See Table 7-4 for part number).
11. Refer to Table 7-6 for replacement label kit.

Figure 5-39. Remote Alarm Harness Installed into Ferrite



1 Cable guide 3
2 Ferrite

5.7.26 Oxygen Connector/Tube Assembly Removal and Replacement

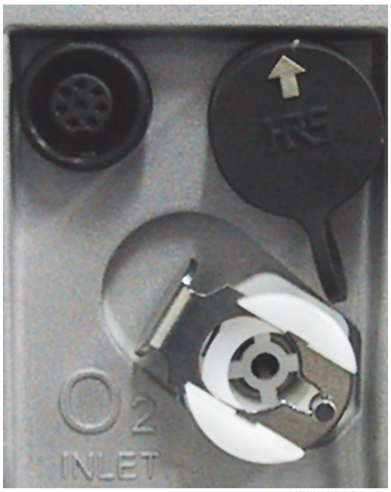
To remove the oxygen connector/ tube assembly:

1. Bend back the tabs on cable guide 2 (Figure 5-35) to release the tubing from the lower housing.
2. Remove the connector lock nut from the inside of the lower housing using a 16-mm open-end wrench or a needle-nose plier (Figure 5-35).
3. Remove the assembly from the back of the lower housing.

To replace the oxygen connector/ tube assembly:

1. Insert the tube assembly through the opening in the back of the lower housing. Ensure the connector is oriented as shown in Figure 5-40.

Figure 5-40. Oxygen Connector Properly Oriented



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2. Install the lock nut on the connector to secure it to the housing. Do not over-tighten.
3. Route the tube through cable guide 2 (Figure 5-35) and secure it by bending the tabs over the tube being careful not to pinch the tube.
4. Connect the tubing from the oxygen solenoid valve to the turbine assembly, and secure it with a tie-wrap using a tie-wrap gun.

5.7.27 Lower Housing Replacement

When replacing the lower housing, you must also transfer the old serial number to the new housing. Use care when removing the serial number. If the serial number is damaged during removal, call your local tech support representative for serial number replacement.

If the serial number label (with window) is damaged during removal, order a new label kit (part number is provided in Table 7-7).

To replace the lower housing:

1. Follow the removal steps listed above to remove all components from the lower housing.
2. Reverse the disassembly steps to reassemble ventilator.

5.8 Post-ventilator Repair Information

If you have made any repairs that have required opening the ventilator housing, you must run the Performance Verification procedures described in Chapter 6.

Table 5-2 describes what testing and calibration is required following ventilator service

Table 5-2. Testing and Calibration Requirements

Type of service	Required test or calibration
Ventilator installation	POST
Software download	1. Software download 2. POST 3. Visual inspection
Biennial checkout (every two years)	1. POST 2. Visual inspection 3. Electrical safety 4. Performance verification testing, including calibrations
15K preventive maintenance	1. POST 2. Visual inspection 3. Electrical safety 4. Performance verification testing, including calibrations
Battery replacement	1. POST 2. Visual inspection 3. Measurements check
Keypad and/or upper housing assembly replacement	1. POST 2. Visual inspection 3. Electrical safety
LCD replacement	1. POST 2. Electrical safety 3. Calibrations 4. Performance verification testing, including calibrations

Table 5-2. Testing and Calibration Requirements (continued)

Type of service	Required test or calibration
CPU PCBA or power management PCBA replacement	1. POST 2. Visual inspection 3. Software download 4. Electrical safety 5. Performance verification testing, including calibrations
Replacement of: • Battery connection PCBA • Buzzer PCBA • Exhalation conical fitting • Exhalation valve solenoid • Inspiratory block • Lower housing • Oxygen connector • Oxygen solenoid • Turbine • Turbine controller PCBA	1. POST 2. Visual inspection 3. Electrical safety 4. Performance verification testing, including calibrations

6 Performance Verification

This chapter describes how to verify the performance of the Puritan Bennett™ 560 Ventilator after it has been repaired or has undergone preventive maintenance. It includes calibration and final functional tests. Refer to Table 2-14 for required tools and service materials.

WARNING

- **Never perform any of the tests described in this chapter while a patient is connected to the ventilator.**
- **This test requires working with exposed electronics connected to AC power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools from touching electrical components.**

6.1 Test Prerequisites

Note:

- This manual assumes English (US) language is selected in the ventilator SETUP (Section 2.12). Ventilator messages will differ, depending upon the language selected.
- Test the device under ambient conditions. If the device has been in use recently, allow it to reach ambient temperature before testing.
- All tests must be run in series, and the device must pass all tests before returning the unit to service.
- Follow your institution's policy for documenting the Performance Verification.
- Set Apnea alarm to OFF in Preferences menu.
- Turn all alarms OFF or set to their minimum and maximum values.

To troubleshoot any performance verification or calibration:

For any performance verification test or calibration that fails, use the following steps to troubleshoot the failure:

1. Verify PTS 2000, BreathLab PTS RPTS application, and ventilator settings and tubing setups are correct.
2. Repeat the test or calibration steps.
3. Replace associated component(s).
4. Check for specific alarm messages. Reference Chapter 4 to troubleshoot calibration failures.

6.2 When to Run Performance Verification

Run performance verification tests following ventilator service as summarized in Table 6-1.

Table 6-1. Testing and Calibration Requirements

Type of service	Required test or calibration
Software download	1. POST 2. Visual inspection
Biennial checkout (every two years) or 15000 hour preventive maintenance	1. POST 2. Visual inspection 3. Electrical safety 4. All calibrations 5. All performance verification testing
Battery, lithium, 3V and any internal harness replacement	1. POST 2. Visual inspection 3. Electrical safety 4. Measurements check. 5. All calibrations. 6. All alarms tests 7. Remote alarm test 8. Power off while ventilating test
Battery, lithium-ion 4.8 Ah memory	1. POST 2. Visual inspection 3. Measurements check 4. Power management software download if not version AL020002 or later
Keypad or upper housing assembly replacement	1. POST 2. Visual inspection 3. Electrical safety
LCD replacement	1. POST 2. Electrical safety 3. Calibrations
CPU or power management PCBA replacement	1. POST 2. Visual inspection 3. Software download, as applicable 4. Electrical safety 5. All calibrations 6. All performance verification testing

Table 6-1. Testing and Calibration Requirements (continued)

Type of service	**Required test or calibration**
Replacement of: • Battery connection PCBA • Buzzer PCBA • Fan	1. POST 2. Visual inspection 3. Electrical safety 4. Measurements check 5. All alarms tests except remote alarm test 6. Power off while ventilating test
Replacement of: • Exhalation conical fitting support • Exhalation valve solenoid • Lower housing assembly • Inspiratory conical fitting • Oxygen female connector • Oxygen solenoid valve • Any internal pneumatic tubing • Turbine/blower • Turbine controller PCBA	1. POST 2. Visual inspection 3. Electrical safety 4. All calibrations 5. All performance verification tests

6.3 Required Materials and Equipment

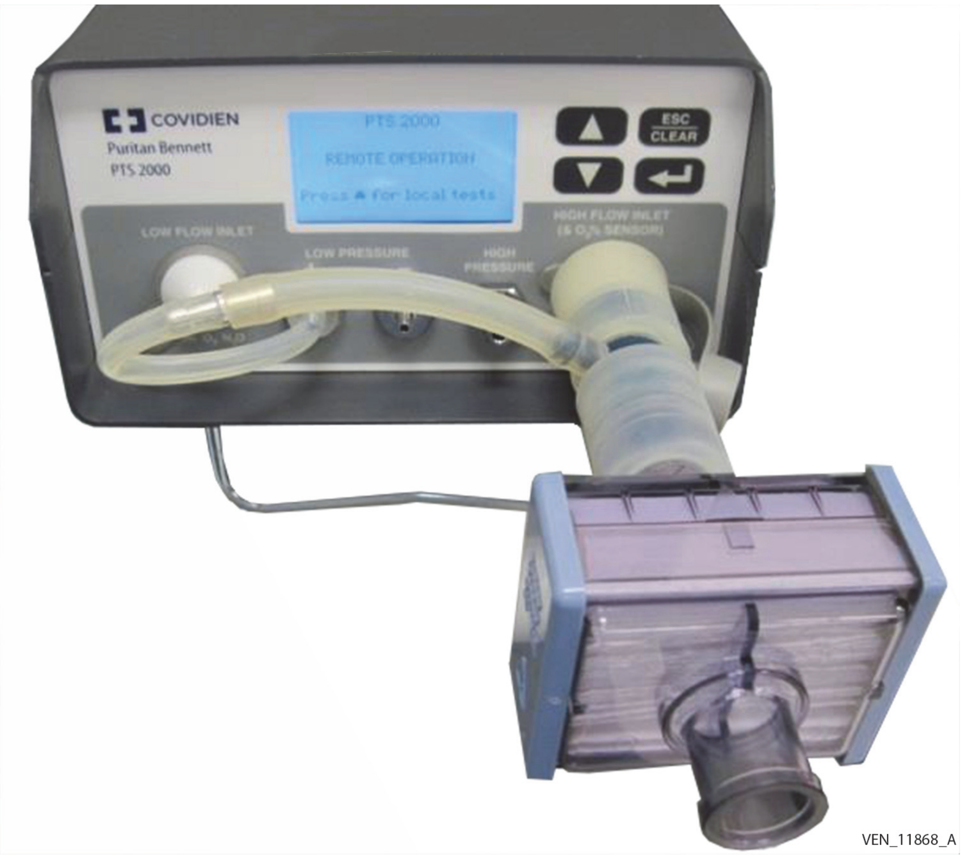
- PC operating on Windows XP or 7
- Serial cable, RS232, DB9 male to DB9 female, 4-074688-00
- USB 2.0 serial converter, local supplier
- PTS 2000 pneumatic analyzer, 4-076185-00
- BreathLab PTS RPTS application software, 4-075356-00
- Patient circuit, pediatric dual-limb, with exhalation valve, 5093900
- Patient circuit, adult dual-limb, with exhalation valve, 5094000
- Test Lung, 1.0-liter, Deluxe Adult, White with Restrictor, P/N LNG800P or equivalent
- Test Lung, 4-liter, 4-075578-00
- Gold standard tube, 22-mm ID X 21.0 inch flex tube, 4-018506-00
- Connector, tubing junction, 22-mm OD barbed with pressure port, 4-011521-00
- Tee connector, 1/8-inch ID tubing, local supplier
- Silicone tubing, 1/8-inch ID, various lengths, 4-008578-00 or equivalent
- Silicone tubing, 7/32-inch ID, various lengths, local supplier
- Silicone tubing, 3/16-inch ID, various lengths, 4-008577-00 or equivalent
- Connector, tubing, 3/16-inch ID to 1/8 inch ID, 4-006104-00 or equivalent
- Silicone barbed coupling, 22-mm ID, 4-003443-00 (3 required)
- Calibration shell, S-231702-00B
- Adapter, 15-mm ID/22-mm OD x barb, 4-002902-00 or equivalent
- Stopper, no. 2, G-061574-00 or equivalent
- Stopper, no. 1, 4-009523-00 or equivalent
- ReFlex filter, barbed, 4-074644-00
- DC power supply, adjustable, minimum 2 A output, Extech model 382202 or equivalent
- DC power, test cable, 10000021
- Digital multimeter, Fluke 87 or equivalent
- Electrical Safety Analyzer, Fluke ESA620 or equivalent
- Fluke ESA620 accessory kit (test leads, etc.)
- Test cable, ground, 10000017
- Remote alarm test box, RA I (black plastic connector), 10000019
- Remote alarm test box, RA II (gray metallic connector), 10005329
- FiO_2 sensor kit, 3814199
- Oxygen connector, male, 2962700
- Oxygen supply, regulated to <7 psi at < 15 lpm, local supplier

- USB memory device, 128 MB to 4 GB, formatted in 32-bit file format, local supplier
- Static-dissipative Field Service Kit, 4-018149-00

6.3.1 PTS 2000 Setup

1. Set the PTS 2000 up as shown (Figure 6-1) and described below.

Figure 6-1. PTS 2000 Setup


COVIDIEN
Puritan Bennett
PTS 2000
PTS 2000
REMOTE OPERATION
Press ▲ for local tests
ESC
CLEAR
LOW FLOW INLET
LOW PRESSURE
HIGH PRESSURE
HIGH FLOW INLET (& O2% SENSOR)
VEN_11868_A

2. Attach a silicone barbed coupling to the high flow inlet port of the PTS 2000.
3. Attach the 22-mm tubing connector with pressure port to the barbed coupling.
4. Attach another barbed coupling to the 22-mm tubing connector.
5. Attach the barbed Re/Flex filter to the barbed coupling, making sure that the flow direction arrow on the filter housing points towards the PTS 2000.
6. Connect one end of a short piece of 3/16-inch ID tubing to the pressure port on the 22-mm tubing junction.
7. Connect the 3/16-inch x 1/8-inch tubing connector to other end of the 3/16 ID tubing.

8. Connect the 3/16-inch x 1/8-inch tubing connector to on end of short piece of 1/8-inch ID tubing.
9. Connect the other end of 1/8-inch ID tubing to (+) low pressure port on the front of the PTS 2000.
10. Connect the USB 2.0 serial converter to a USB port on the PC.
11. Connect the serial cable to the USB 2.0 serial converter.
12. Connect the other end of the USB serial converter to a serial port on the rear of the PTS 2000.
13. The USB port must be set to COM1 on the PC for the USB serial converter to communicate with the PTS 2000.
14. Power on the PTS 2000 and allow a ten (10) minute warm-up.
15. Perform oxygen sensor calibration per the PTS 2000 User's Manual.
16. Set the PTS 2000 to REMOTE OPERATION mode before launching BreathLab PTS RPTS application software.

6.4 Electrical Safety Test

This test verifies that the Puritan Bennett 560 Ventilator meets the leakage current requirements of IEC 60601-1:1990 or 1988 for Class II, Type BF devices. You may use any electrical safety analyzer capable of performing the required tests for this device classification. Refer to Table 6-2 for appropriate test limits. Refer to the analyzer operating instructions for details on test setup and test steps.

Required equipment:

- electrical safety analyzer
- electrical safety test ground cable
- patient lead test cable.

WARNING

- **Never perform any of the tests described in this chapter while a patient is connected to the ventilator.**
- **This test requires working with exposed electronics connected to AC power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools from touching electrical components.**

To perform an electrical safety test:

1. Test the ventilator according to the electrical safety analyzer’s instructions.
2. Verify the test results are within the listed limits.

Table 6-2. Electrical Safety Test Limits

Test	Line configuration	Test limit
Enclosure Leakage Current	Normal Condition (NC)	100 µA
Enclosure Leakage Current	Normal Condition/Reversed Mains (NCRM)	100 µA
Enclosure Leakage Current	Open Supply (OS)	500 µA
Enclosure Leakage Current	Open Supply/Reversed Mains (OSRM)	500 µA
Mains on Applied Part	Single Fault Condition (SFC)	5000 µA
Mains on Applied Part	Single Fault Condition, Reversed Mains	5000 µA
Patient Leakage Current, AC	Open Supply (OS)	500 µA
Patient Leakage Current, AC	Normal Condition (NC)	100 µA
Patient Leakage Current, AC	Open Supply/Reversed Mains (OSRM)	500 µA
Patient Leakage Current, AC	Normal Condition/Reversed Mains (NCRM)	100 µA
Patient Leakage Current, DC	Open Supply (OS)	500 µA
Patient Leakage Current, DC	Normal Condition (NC)	100 µA
Patient Leakage Current, DC	Open Supply/Reversed Mains (OSRM)	500 µA
Patient Leakage Current, DC	Normal Condition/Reversed Mains (NCRM)	100 µA

6.5 Power-on Indicators Check

WARNING

- **Never perform any of the tests described in this chapter while a patient is connected to the ventilator.**
- **This test requires working with exposed electronics connected to AC power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools from touching electrical components.**

To perform a check of the power-on indicators:

1. Connect the ventilator to AC power.
2. Switch the ventilator power switch to the ON position.
3. Verify the red, yellow, and blue LEDs flash briefly and two alarm tones sound.
4. Verify the blue LED lights and remains lit.
5. Verify the AC LED lights and remains lit.

6.6 Ventilator Configuration

WARNING

- **Never perform any of the tests described in this chapter while a patient is connected to the ventilator.**
- **This test requires working with exposed electronics connected to AC power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools from touching electrical components.**

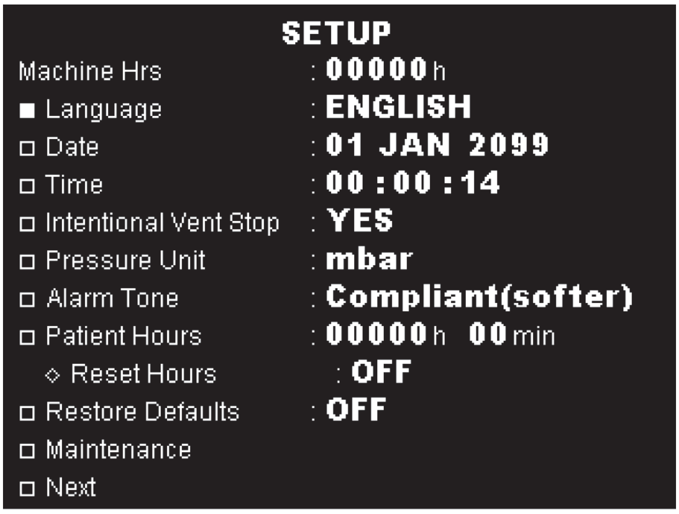
The Performance Verification process requires service technicians access the Setup screen to configure the ventilator, if not already configured. Configuration includes setting the language, date, time, resetting patient hours to zero, and turning on altitude compensation from the Maintenance Mode > Measurement Check menu. Setting the current time and date provides a frame of reference for any technical faults or errors that may occur during calibration or verification steps.

6.6.1 SETUP Menu Access

To access the SETUP menu:

1. Ensure the ventilator power switch is in the OFF position.
2. Press and hold the **ALARM CONTROL** key while simultaneously switching the ventilator power switch to the ON position. Continue holding the ALARM CONTROL key until the Setup screen appears (Figure 6-2).

Figure 6-2. Setup Screen



SETUP

Machine Hrs : 00000 h

■ Language : ENGLISH

☐ Date : 01 JAN 2099

☐ Time : 00 : 00 : 14

☐ Intentional Vent Stop : YES

☐ Pressure Unit : mbar

☐ Alarm Tone : Compliant(softer)

☐ Patient Hours : 00000 h 00 min

◇ Reset Hours : OFF

☐ Restore Defaults : OFF

☐ Maintenance

☐ Next

VEN_10164_B

Information displayed on this screen is for illustrative purposes only

Note:
If the ventilator fails to enter SETUP, stop ventilation by pressing the Ventilation ON/OFF key for 3 seconds and pressing again to confirm stop. Power off the ventilator then repeat steps 1 and 2 above.

6.6.2 Ventilator Settings

To configure ventilator settings:

1. Access the SETUP menu. Reference Section 6.6.1.
2. Use the **UP** or **DOWN** arrow keys to move the cursor as desired.
3. Place the cursor on LANGUAGE.
4. Press **ENTER**.
5. Use the **UP** or **DOWN** arrow keys to select ENGLISH (US).
6. Press **ENTER**.
7. Place the cursor on **DATE**.
8. Press **ENTER**.
9. Use the **UP** or **DOWN** arrow keys to set the current date.
10. Press **ENTER**.
11. Place the cursor on **TIME**.
12. Press **ENTER**.
13. Use the **UP** or **DOWN** arrow keys to set the current time.
14. Press **ENTER**.

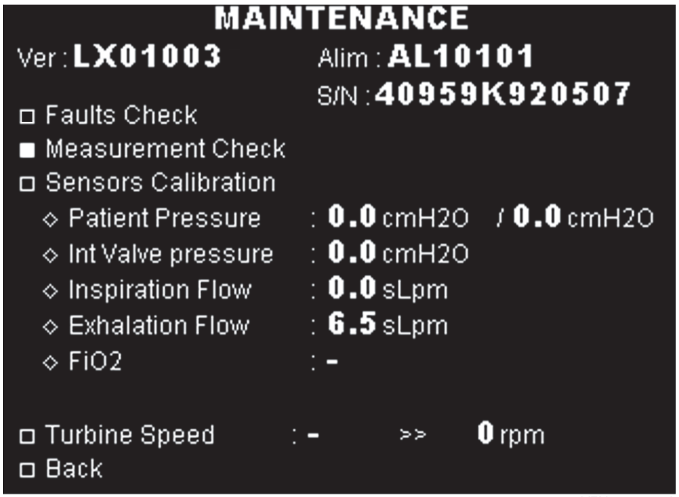
6.7 Maintenance Mode

6.7.1 Faults Check

To review the Faults Log:

1. Access the **SETUP** menu. Reference Section 6.6.1.
2. Use **UP** or **DOWN** arrow keys to move cursor as desired.
3. Select **MAINTENANCE**.
4. Press **ENTER**.
5. Select **FAULTS CHECK**.
6. Press **ENTER** to access the Faults Log.
7. Review the Faults Log and determine any corrective action necessary from the displayed fault codes.

Figure 6-3. Maintenance Screen



MAINTENANCE

Ver : **LX01003**　Alim : **AL10101**

S/N : **40959K920507**

☐ Faults Check

■ Measurement Check

☐ Sensors Calibration

- ◇ Patient Pressure : **0.0** cmH2O / **0.0** cmH2O
- ◇ Int Valve pressure : **0.0** cmH2O
- ◇ Inspiration Flow : **0.0** sLpm
- ◇ Exhalation Flow : **6.5** sLpm
- ◇ FiO2 : -

☐ Turbine Speed : - >> **0** rpm

☐ Back

VEN_11213_A

Values shown are for reference only

6.7.2 Measurements Check

WARNING

- **Never perform any of the tests described in this chapter while a patient is connected to the ventilator.**
- **This test requires working with exposed electronics connected to AC power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools from touching electrical components.**

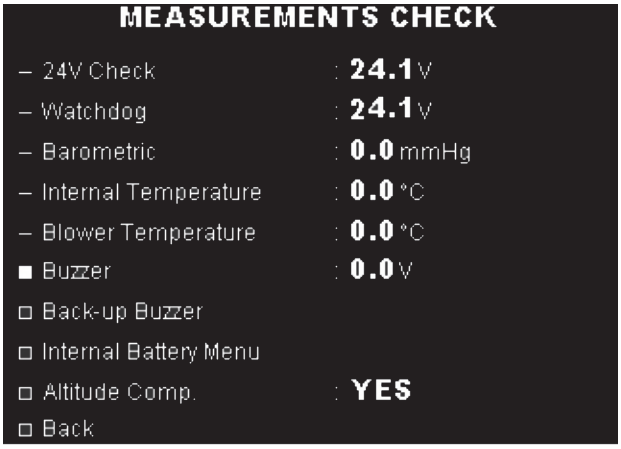
To perform the measurements check:

Before running **Measurements Check**, warm up the ventilator for at least ten minutes by running turbine at full speed with calibration shell attached to inspiratory port. See "To run turbine at full speed:" on page 6-22. This is particularly important so that the blower will be at the correct temperature during the **Measurements Check**.

1. Disconnect the ventilator from any external DC power source.
2. Connect the ventilator to AC power.
3. Power on ventilator in normal mode and set default parameters per the tables in Section 6.15.
4. Ensure that **Key Sound** is set to **Accept Tone** in **PREFERENCES**.
5. Power on ventilator in Maintenance mode (Section 6.7).
6. Access the **SETUP** menu.

7. Use **UP** or **DOWN** arrow key to select **MAINTENANCE**.
8. Press **ENTER** to access the **MAINTENANCE** menu.
9. Select **Measurements Check** (Figure 6-4).

Figure 6-4. Measurements Check Screen



MEASUREMENTS CHECK

– 24V Check : **24.1** V
– Watchdog : **24.1** V
– Barometric : **0.0** mmHg
– Internal Temperature : **0.0** °C
– Blower Temperature : **0.0** °C
■ Buzzer : **0.0** V
☐ Back-up Buzzer
☐ Internal Battery Menu
☐ Altitude Comp. : **YES**
☐ Back

VEN_10162_A

10. Press **ENTER.**
11. After the **Measurements Check** screen appears, verify the displayed values are within the listed specifications summarized in Table 6-3.

Table 6-3. Measurements Check Specifications

Parameter	Specification	Troubleshooting steps
24 V check	23.5 V- 24.5 V	1. Ensure Power Management cable is connected properly and is not damaged. 2. Verify 24 V on connector J7 (see Section 4.4.4.2). 3. Replace Power Management PCBA (seeSection 5.7.22). 4. Replace CPU PCBA (see Section 5.7.10).
Watchdog	23.5 V - 24.5 V	Replace CPU PCBA (see Section 5.7.10).
Barometric pressure	Ventilator reading is ± 11 mmHg of PTS 2000 barometric pressure measurement	1. Ensure no tubing is connected to the barometric pressure transducer. 2. Replace CPU PCBA (see Section 5.7.10).

Table 6-3. Measurements Check Specifications (continued)

Parameter	Specification	Troubleshooting steps
Internal temperature	30°C - 55°C (86°F - 131°F)	1. Relocate ventilator to a cooler location. 2. Ensure side and front cooling vents are not obstructed. 3. Ensure fan is operating properly. 4. Replace Power Management PCBA (see Section 5.7.22).
Blower temperature	35°C - 65°C (95°F - 149°F)	1. Warm up the ventilator for ten minutes in maintenance mode with calibration shell attached to inspiratory port and turbine speed set to maximum. 2. Ensure turbine control cable is connected properly and not damaged. 3. Replace turbine (see Section 5.7.19).
Buzzer	Long beep sounds and Buzzer voltage = 1.7 V - 2.1 V	1. Verify default parameters are set as listed in Section 6.15. It is particularly important that Key Sound is set to Accept tone in Preferences menu for correct Buzzer voltage result. 2. Charge the buzzer battery by allowing ventilator to remain powered on and connected to AC power for at least 30 minutes and up to 2 hours. 3. Verify that PCBA-mounted switch on buzzer PCBA is set to OFF. 4. Replace Buzzer PCBA (see Section 5.7.15). 5. Replace CPU PCBA (see Section 5.7.10).

Table 6-3. Measurements Check Specifications (continued)

Parameter	Specification	Troubleshooting steps
Backup buzzer	Long beep sounds	Replace CPU PCBA (see Section 5.7.10).
Altitude Compensation	YES	Set to YES in Measurement Check menu.
Internal battery menu		
Supplier	Approved supplier	If supplier is not displayed: 1. Power management software download if not version AL020002 or later. 2. Replace lithium-ion battery (see Section 5.7.4).
First use date	Record value	N/A
Theoretical capacity	4800 mAh	Replace lithium-ion battery (see Section 5.7.4).
Capacity	3840 mAh minimum	Replace lithium-ion battery (see Section 5.7.4).
Cycles done	N/A	N/A

Table 6-3. Measurements Check Specifications (continued)

Parameter	Specification	Troubleshooting steps
Battery voltage	23.5 V to 29.7 V	1. Connect ventilator to AC power source to charge battery. 2. Replace lithium-ion battery (see Section 5.7.4). 3. Inspect electrical contacts and proper connection of Battery Connection PCBA and battery for damage or oxidation. 4. Verify proper connection of Battery Connection PCBA and Power Management PCBA. 5. Replace Battery Connection PCBA (see Section 5.7.24). 6. Replace Power Management PCBA (see Section 5.7.22).
Battery temperature	0°C - 40°C (32°F - 104°F)	7. Verify airflow vents in battery cover are not obstructed. 8. Check for proper operation of fan. 9. Replace lithium-ion battery (see Section 5.7.4).

12. Select **Buzzer.**
13. Press **ENTER**.
14. Verify a long beep sounds and voltage displayed is 1.7 V to 2.1 V.

Note:

For Buzzer voltage above 2.1 V, allow buzzer battery to charge by leaving ventilator powered on in maintenance mode for 30 minutes and up to two hours. For Buzzer voltage below 1.7 V, verify **Key Sound** is set to **Accept tone** in **PREFERENCES** menu.

15. Select **Back-up Buzzer**.
16. Press **ENTER**.
17. Verify a long beep sounds.
18. Select **Internal Battery Menu**.
19. Press **ENTER**.
20. Verify the displayed values are within the listed specifications in Table 6-3.

21. Select **Altitude Comp**.

22. Press **ENTER**.

WARNING

The default setting for altitude compensation is *YES*. Altitude compensation should always be set to *YES* for accurate volume delivery calculations at all elevations.

23. Press the **UP** or **DOWN** arrow keys to select YES if it is not already set to YES.

24. Press **ENTER.**

Note:

The default setting for altitude compensation is YES. Altitude compensation should always be set to YES for accurate volume delivery calculations at all elevations.

25. Select **BACK**.

26. Press **ENTER** to return to the **MAINTENANCE** menu.

6.7.3 Sensors Calibration

This series of steps calibrates the patient pressure sensors and exhalation valve (internal valve) pressure sensor.

WARNING

- **Never perform any of the tests described in this chapter while a patient is connected to the ventilator.**
- **This test requires working with exposed electronics connected to AC power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools from touching electrical components.**

6.7.3.1 Patient Pressure Sensors Calibration

The Patient Pressure test provides pressure offsets at 0 and 40 cmH_2O to calibrate the internal and proximal pressure sensors.

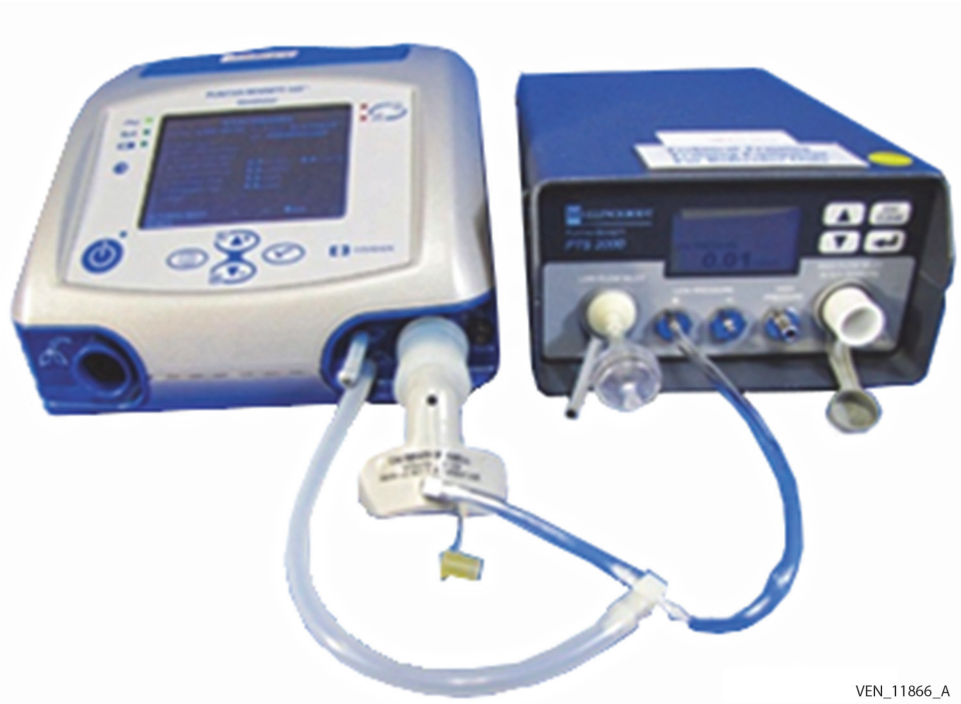
Required equipment:

- PTS 2000 pneumatic calibration analyzer
- calibration shell
- tee connector
- 1/8″ ID silicone tubing
- 7/32″ ID silicone tubing
- silicone coupling.

To set up Patient Pressure Sensor and Exhalation Valve (Internal Valve) Pressure Sensor calibration:

1. Connect the ventilator and the PTS 2000 (Figure 6-5):
2. Block the exhalation valve pilot port using a section of 1/8 inch tubing blocked at one end.
3. Use a 22-mm ID barbed coupling to connect the calibration shell assembly to the ventilator inspiratory port.

Figure 6-5. Pressure Sensors Calibration Test Setup



4. Connect the low pressure tube from the calibration assembly to the positive (+) low pressure port on the front of the PTS ventilator tester.
5. Set the PTS 2000 display to Low Pressure cmH_20.
6. Verify PTS 2000 Low Pressure reads 0.0 ± 0.1 cmH_2O. If the PTS 2000 low pressure is not 0.0 ± 0.1 cmH_2O, zero the PTS 2000 low pressure transducer per the PTS 2000 *User's Manual* before proceeding.

To calibrate the Patient Pressure Sensor:

1. Enter the ventilator **MAINTENANCE** Menu.
2. Select **Sensors Calibration.**
3. Press **ENTER**.
4. Select **Patient Pressure**.

5. Press **ENTER**.
6. Press and hold **ENTER** to accept the 0 (zero) reading.
7. Adjust the Turbine Speed using the **UP** or **DOWN** arrow keys to read 39.80 to 40.20 cmH$_2$O on the PTS 2000 low pressure measurement.
8. Press and hold **ENTER** until a short beep sounds. A long beep indicates the calibration failed.
9. Press **MENU** twice to verify 39.60 cmH$_2$O to 40.40 0 cmH$_2$O is measured on the PTS 2000 for low pressure.
10. Press **MENU** to complete the calibration check.

To calibrate Exhalation Valve (Internal Valve) Pressure Sensor:

1. Use the down arrow key to place the cursor at the **Int. Valve pressure** position.
2. Press **ENTER**.
3. Confirm successful calibration, indicated by a short beep. If a long beep sounds, the calibration failed.

6.7.3.2 Inspiratory flow Sensor Calibration

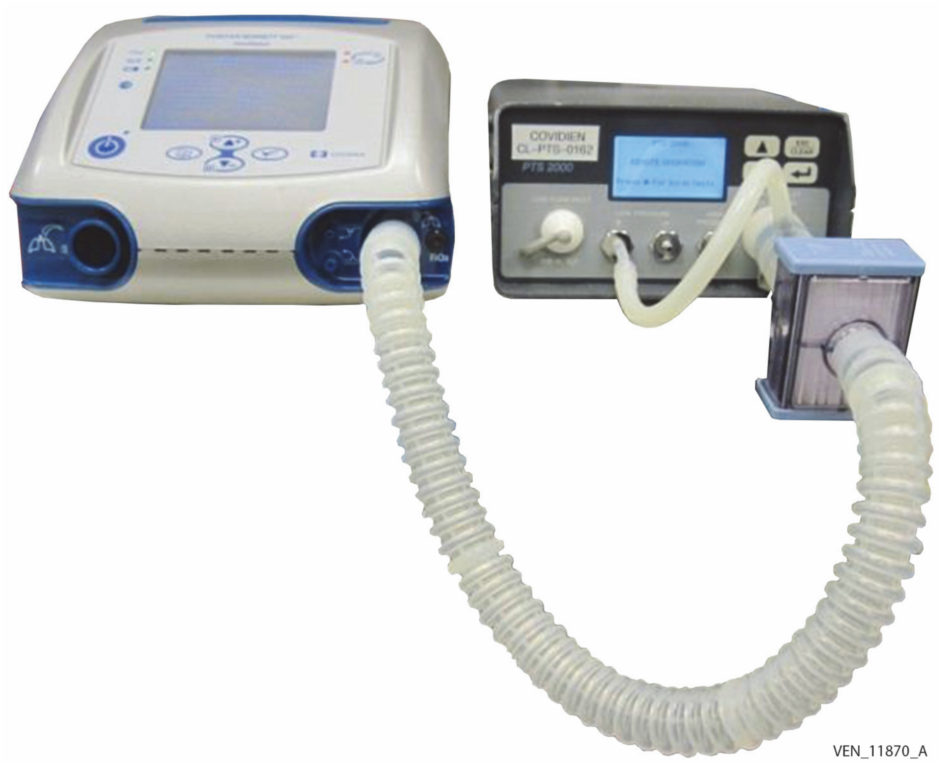
Required equipment:

- PTS 2000 pneumatic calibration analyzer
- gold standard tube, 22-mm dia. flex tube.

To calibrate the inspiratory flow sensor:

1. Connect a gold standard (22-mm) tube to the ventilator inspiratory port and the high flow inlet of PTS 2000 as shown in Figure 6-6.

Figure 6-6. Inspiration Flow Calibration Test Setup



2. Set the PTS 2000 to measure HIGH FLOW, SLPM, air.
3. Ensure the cap on the PTS 2000 High Flow exhaust port is removed.
4. Using the **UP** or **DOWN** arrow keys, place the cursor at the **Inspiration Flow** position.
5. Press **ENTER**.
6. Verify the display flashes 0 and the PTS 2000 reads 0.00 ± 0.10 slpm.
7. Press and hold **ENTER** to accept the calibration and proceed to the next calibration point.
8. For each of the flows listed below, use the **UP** or **DOWN** arrow keys to adjust the turbine speed to obtain the specified flow measurement after each reading stabilizes.

9. Press and hold **ENTER** until a short beep sounds.
    - 0 slpm ± 0.10 slpm
    - 4.90 slpm to 5.10 slpm
    - 11.76 slpm to 12.24 slpm
    - 19.6 slpm to 20.4 slpm
    - 36.26 slpm to 37.74 slpm
    - 58.8 slpm to 61.2 slpm
    - 88.2 slpm to 91.8 slpm
    - 127.4 slpm to 132.6 slpm

If a long beep sounds after any calibration step, the calibration failed and the value is discarded. The previous value is automatically restored.

To verify the inspiration flow calibration:

1. Place the cursor at the Inspiration Flow position.
2. Press **MENU**.
3. Verify the PTS 2000 readings are within the listed ranges.
    - 0 slpm ± 0.10 slpm
    - 4.50 slpm to 5.50 slpm
    - 11.1 slpm to 12.9 slpm
    - 19.0 slpm to 21.0 slpm
    - 35.1 slpm to 38.9 slpm
    - 57.0 slpm to 63.0 slpm
    - 85.5 slpm to 94.5 slpm
    - 123.5 slpm to 136.5 slpm
4. Press **MENU** to complete the check.

To troubleshoot inspiratory flow calibration failures:

1. Check vent and PTS 2000 setup.
2. Verify the PTS 2000 and ventilator have warmed up for ten (10) minutes.
3. Recalibrate inspiratory flow.
4. Check for kinked or disconnected internal pneumatic tubing.

6.7.3.3 Exhalation Flow Calibration

Each time the exhalation block is replaced, the exhalation flow sensor calibration must be completed. There is no need to use the PTS 2000 for this calibration. Appropriately set the preferences for patient circuit based on the patient circuit being used. This procedure describes how to perform the exhalation flow sensor calibration using an adult dual-limb patient circuit, but tests may also use a pediatric dual-limb patient circuit.

Required equipment:

- adult dual-limb patient circuit or pediatric dual-limb patient circuit
- 22-mm barbed to 22-mm conical connector
- No. 1 stopper.

To calibrate the exhalation flow sensor:

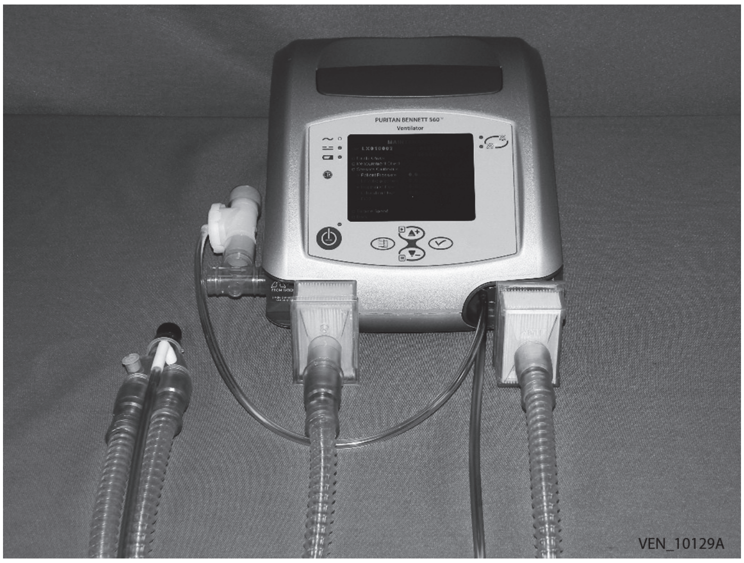
1. Remove the gold standard tube from the PTS 2000 and the ventilator.
2. Connect an adult dual-limb patient circuit to the ventilator.

Note:

Ensure the ventilator Preferences have been set to "OFF" for pediatric dual-limb patient circuit before calibration when using an adult dual-limb patient circuit.

3. Insert a no. 1 stopper into the patient wye.

Figure 6-7. Exhalation Flow Sensor Calibration Test Setup



4. Use the **UP** or **DOWN** arrow keys to place the cursor at the **Exhalation Flow** position.
5. Press **ENTER**. The ventilator automatically performs the calibration at eight (8) flow points: 0 slpm, 5 slpm, 12 slpm, 20 slpm, 37 slpm, 60 slpm, 90 slpm, 130 slpm.
6. Verify the ventilator emits a short beep after successfully calibrating each flow rate. A short beep indicates pass while a long beep indicates failure.
7. Verify all of the flow points pass calibration as indicated by a short beep.

Note:
In the event of a calibration error, the ventilator emits a long beep. The ventilator uses the previously saved value as the default and automatically switches to the next calibration point. Verify proper exhalation valve and patient circuit connections before attempting recalibration.

8. Perform exhalation flow sensor calibration verification by pressing **MENU** to successively step through each of these flow measurements: 0 slpm, 5 slpm, 12 slpm, 20 slpm, 37 slpm, 60 slpm, 90 slpm, and 130 slpm, verifying that the Inspiration Flow reading is within test limits as specified.

   0 slpm ± 0.10 slpm

   4.50 slpm to 5.50 slpm

   11.1 slpm to 12.9 slpm

   19.0 slpm to 21.0 slpm

   35.1 slpm to 38.9 slpm

   57.0 slpm to 63.0 slpm

   85.5 slpm to 94.5 slpm

   123.5 slpm to 136.5 slpm

Note:
If any exhalation flow verification is not within test limits, perform Exhalation Flow Sensor calibration again and verify each calibration point passes as indicated by a short beep.

9. Press **MENU** once more to complete the calibration check.

6.8 Functional Tests

WARNING

- **Never perform any of the tests described in this chapter while a patient is connected to the ventilator.**
- **This test requires working with exposed electronics connected to AC power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools from touching electrical components.**

6.8.1 Flow Sensor Capacity Test

This test checks the maximum flow capability of the turbine when there is no pressure in the circuit. An external measurement device (PTS 2000) is not used during this test.

To perform the flow sensor capacity test:

1. Remove all tubing from the ventilator.
2. If not already in Maintenance mode, access the Maintenance menu. Reference Section 6.7.
3. Use the **UP** and **DOWN** arrow keys to place the cursor at the *Turbine Speed* position.

4. Press **MENU**.
5. Verify the inspiration flow reading is > 145 slpm on the ventilator display.
6. Use the **UP** and **DOWN** arrow key to stop the turbine.

6.8.2 Turbine Performance Test

This test verifies the turbine can develop sufficient pressure during a no-flow condition.

Required equipment:

- PTS 2000 pneumatic calibration analyzer
- calibration shell
- tee connector
- 1/8” ID silicone tubing
- 7/32” ID silicone tubing
- silicone coupling.

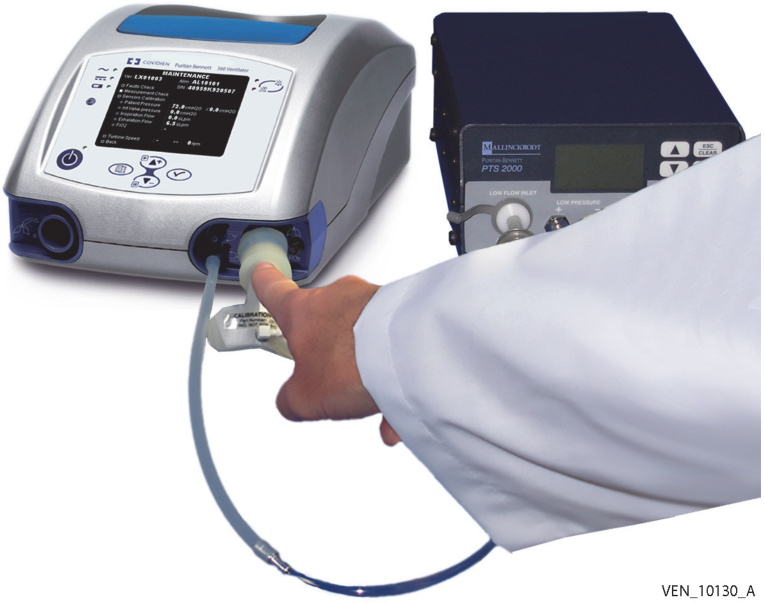
To run turbine at full speed:

1. Access the **SETUP** menu (Section 6.6.1).
2. Use **UP** or **DOWN** arrow keys to move cursor as desired.
3. Select **MAINTENANCE**.
4. Press **ENTER**.
5. Select **TURBINE SPEED**.
6. Press **MENU**.

To run the turbine performance test:

1. With the ventilator and PTS 2000 in the same setup from the previous test, connect the calibration shell to the To Patient port on the ventilator using the 22-mm ID barbed silicone coupling (Figure 6-8).

Figure 6-8. Test Setup for Turbine Performance Test

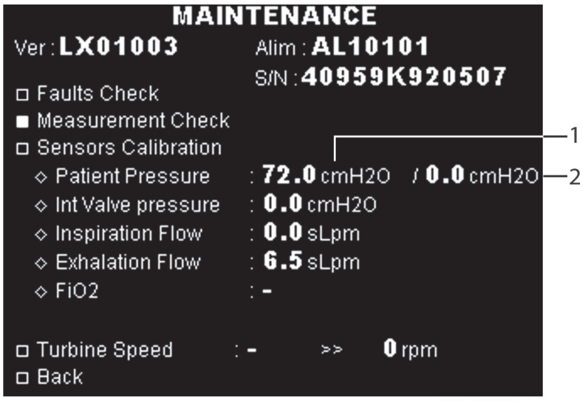


2. If necessary, set the PTS 2000 to measure LOW PRESSURE, cmH_2O.
3. Verify that low pressure reads 0.0 ± 0.1 on PTS 2000. If PTS 2000 low pressure measurement is not 0.0 ± 0.1 cmH_2O, zero the PTS 2000 low pressure transducer per the PTS 2000 *User's Manual* before proceeding.
4. Use the **UP** or **DOWN** arrow keys to position the cursor at the **Turbine Speed** position.
5. Press **MENU** to command the turbine to full speed.
6. Block the hole in the calibration shell for no more than three seconds while verifying the PTS 2000 indicates pressure reading > 70 cmH_2O, and the ventilator displays patient pressure > 70 cmH_2O.

Caution
Do not block hole for more than 3 seconds or turbine damage could result.

7. Unblock the hole in the calibration shell.
8. Remove tubing from patient pressure port.
9. Verify the patient pressure reading (in the right-hand column of the ventilator display) is 0 ± 0.5 cmH_2O. If the right-hand column reads > 70 cmH_2O and the left-hand column reads 0 ± 0.5 cmH_2O, the internal tubes may be reversed (Figure 6-9).

Figure 6-9. Pressure Calibration Points in Turbine Performance Test


MAINTENANCE

Ver : **LX01003** Alim : **AL10101**

S/N : **40959K920507**

☐ Faults Check

■ Measurement Check

☐ Sensors Calibration

◇ Patient Pressure : **72.0** cmH2O / **0.0** cmH2O

◇ Int Valve pressure : **0.0** cmH2O

◇ Inspiration Flow : **0.0** sLpm

◇ Exhalation Flow : **6.5** sLpm

◇ FiO2 : -

☐ Turbine Speed : - >> **0** rpm

☐ Back

VEN_10163_A

1 Reading should be > 70 cmH_2O

2 Reading should be 0 ± 0.5cmH_2O

10. Press the **UP** or **DOWN** arrow key to stop the turbine.

6.8.3 Oxygen Solenoid Functional Test

This test ensures the proper function of the oxygen solenoid valve.

WARNING

Ensure the oxygen supply pressure to the machine never exceeds 7 psi (50 kPa) or a flow of 15 lpm.

Required equipment:

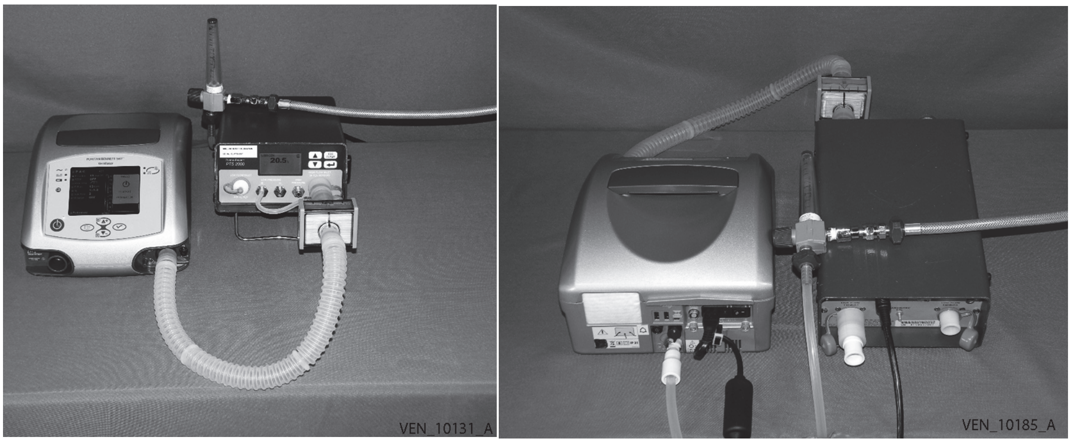
- PTS 2000 pneumatic calibration analyzer
- standard tube, 22-mm dia. flex tube
- external oxygen source with 3/16-in. inlet tubing
- oxygen connector, male
- exhalation valve assembly.

To perform the oxygen solenoid functional test:

1. Set the PTS 2000 to display Oxygen% measurement.
2. Connect an oxygen supply to the O_2 inlet connector at the rear of the ventilator.
3. Adjust the source pressure to < 7 psi (at no more than 15 lpm).
4. Ensure the oxygen supply is turned off.

5. Connect a gold standard tube from the ventilator To Patient port to the High Flow Inlet on the PTS 2000.
6. Block the exhalation valve pilot pressure port or attach exhalation valve pilot pressure line to the pilot pressure port.
7. With ventilator in normal ventilation mode on standby, set ventilation parameters to default settings.
   - Ventilation mode: P A/C
   - Pi: 15 cmH_20
   - PEEP: OFF
   - Rise Time: 2
   - R-Rate: 10
   - Insp Time: 1.3s (I:E ratio: 1:3.6 or I/T= 22%)
   - Insp Sens: 2
   - Vt Target: OFF
   - VTI mL Min: OFF
   - VTI mL Max: OFF
   - VTE mL Min: OFF
   - VTE mL Max: OFF
   - R tot bpm High: OFF
8. Start ventilation by pressing **Ventilation On/Off** key.
9. After approximately 30 seconds, verify the PTS 2000 oxygen% measures: 21.0% ± 3.0%.
10. Stop ventilation.
11. Turn on the oxygen supply (< 7 psi, < 15 lpm).
12. Start ventilation.
13. After approximately 30 seconds, verify the PTS 2000 oxygen% reading: > 25.0%.
14. Turn off the oxygen supply and disconnect the oxygen supply hose and connector from the ventilator while continuing ventilation.
15. Allow the PTS 2000 oxygen% reading to return to 21%, to ensure the system is purged of oxygen.
16. Stop ventilation by placing the ventilator into standby mode.
17. Disconnect the gold standard tube from the ventilator.

Figure 6-10. Test setup for Oxygen Solenoid Functional Test



front view

rear view

6.9 Breath Delivery Accuracy Tests

WARNING

- **Never perform any of the tests described in this chapter while a patient is connected to the ventilator.**
- **This test requires working with exposed electronics connected to AC power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools from touching electrical components.**

Note:

This test is designed to verify ventilator output (volume accuracy ± (10 mL + 10%) of setting; pressure accuracy ± (2 cmH_2O + 8%) of setting using the PTS 2000 in combination with BreathLab RPTS software application.

Required equipment:

- PTS 2000 pneumatic calibration analyzer
- pediatric dual-limb patient circuit
- adult dual-limb patient circuit
- 1.0-L test lung
- 4-L test lung
- gold standard tube, 22-mm dia. flex tube
- tee connector
- 1/8-in. ID silicone tubing
- 7/32-in. ID silicone tubing
- silicone coupling
- calibration shell.

Preconditions:

- PTS 2000 and ventilator must have been powered on for a minimum of ten (10) minutes for proper warm-up.
- Turn off all settable alarms.
- Access the SETUP menu and set Pressure Unit to cmH_2O and relative pressure to YES.
- Due to the test setup, the ventilator does not display a VTE reading during volume tests.

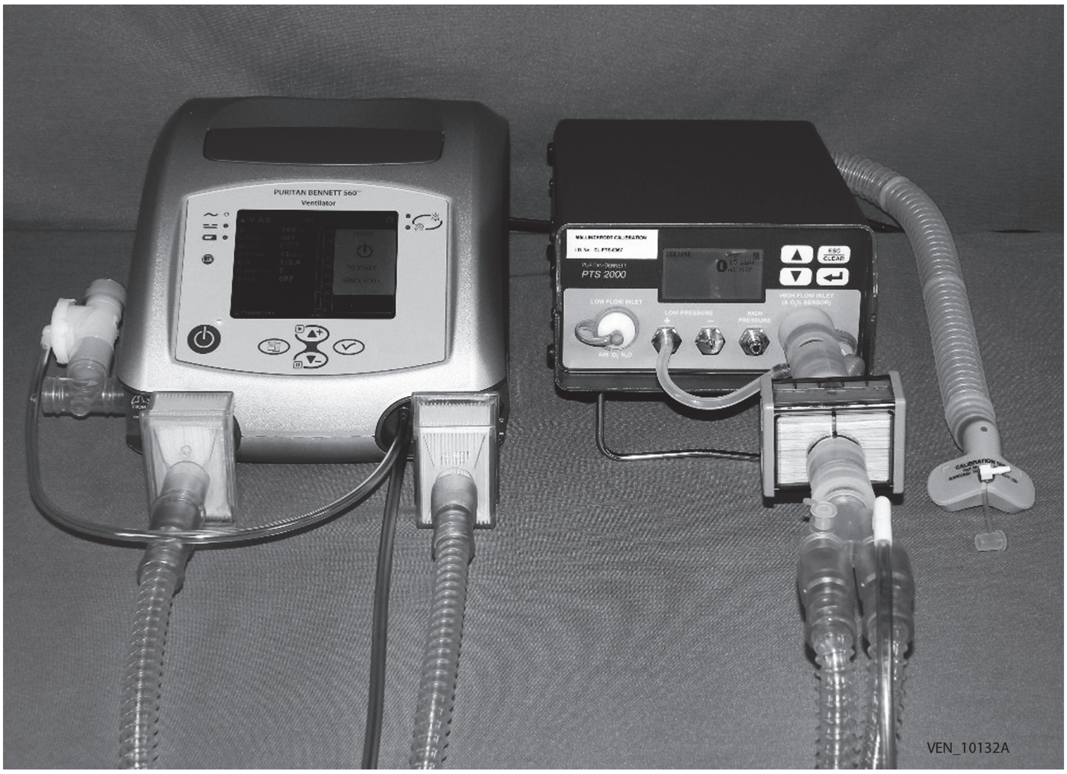
6.9.1 Pediatric Volume Accuracy

To verify pediatric volume accuracy:

1. Power on the ventilator in normal ventilation mode on standby.
2. Enter **Preferences** menu.
3. Set pediatric circuit to **YES**.
4. Connect pediatric dual-limb patient circuit and exhalation valve to ventilator.
5. Block pediatric dual-limb patient circuit wye using no. 1 stopper.
6. Press **MENU** to access the **Alarms** menu.
7. Select **VTE**.
8. Press **ENTER** twice so that OFF is flashing in middle (Current) column.
9. While **OFF** is flashing, use the **UP** or **DOWN** arrow key to select **YES**.
10. Press **ENTER** to perform exhalation flow calibration.

11. Connect the pediatric patient circuit tubing wye to the PTS 2000 high flow inlet filter (Figure 6-11).

Figure 6-11. Pediatric Volume Accuracy Test Setup


PURITAN BENNETT 560
Ventilator
PTS 2000
LOW FLOW INLET
LOW PRESSURE
HIGH PRESSURE
HIGH FLOW INLET
ESC
CLEAR
CALIBRATION
VEN_10132A

12. Connect the gold standard (22-mm) tube to the PTS 2000 High Flow outlet.
13. Connect the calibration shell to the other end of the gold standard tube.
14. Set the PTS 2000 to Volume, Air, mL, BTPS, threshold 15 slpm, and Flow-by Tare 4 slpm.
15. With ventilator in normal ventilation mode on standby, set ventilation to the listed parameters.

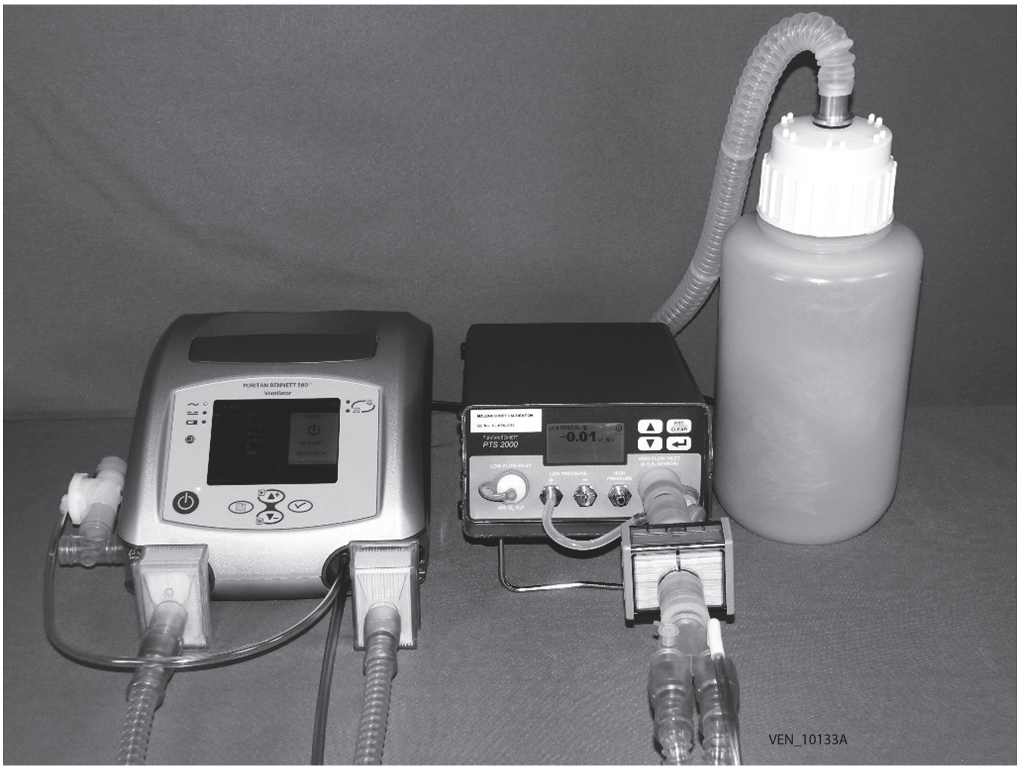
16. Select the following settings:
    - Mode: V A/C
    - VT: 150ml
    - PEEP: OFF
    - Flow pattern: SQ
    - R-Rate: 30 BPM
    - Insp Time: 0.5s (I:E ratio: 1:3.0)
    - Insp Sens: 3
    - Sigh: OFF
    - PIP Min: 2
    - PIP Max: 60
    - VTE mL Min: OFF
    - VTE mL Max: OFF
    - R tot bpm Max: OFF
17. Start ventilation by pressing the **Ventilation On/Off** key.
18. After the ventilator delivers approximately 15 breaths, compare the VTI reading displayed in the ventilator's Alarms menu screen is 125 mL to 175 mL.
19. Verify that the delivered volume measured by the PTS 2000 is within calculated test limits (VtI ± (8% + 10 mL)).
20. Stop ventilation by using the **Ventilation On/Off** key.

6.9.2 Pediatric Pressure Accuracy

To verify pediatric pressure accuracy:

1. Connect the 4-L test lung to the other end of the standard tube (Figure 6-12).

Figure 6-12. Pediatric Pressure Accuracy Test Setup



2. Set the PTS 2000 to Low Pressure, cmH_2O.

3. With the ventilator in normal ventilation mode on standby, set the listed parameters.
    - Mode: P A/C
    - Pi: 10 cmH_2O
    - PEEP: OFF
    - Rise time: 1
    - R-Rate: 10 BPM
    - Insp Time: 1.3 sec (I:E = 1:3.6 or I/T = 22%)
    - Insp Sens: 5
    - Vt Target: OFF
    - VTI mL Min: OFF
    - VTI mL Max: OFF
    - VTE mL Min: OFF
    - VTE mL Max: OFF
    - R tot bpm High: OFF

Note:

Turn OFF all settable alarms.

4. Start ventilation by pressing the Ventilation **On/Off** key.
5. After the ventilator delivers approximately 15 breaths, verify the Pi reading displayed in the alarm menu screen is 8 cmH_2O to 12 cmH_2O.
6. Verify the Pi reading displayed in the ventilator's alarms menu screen is within calculated test limits (PTS 2000 peak low pressure measurement ± (8.75% + 2.04 cmH_2O)).
7. Stop ventilation by using the Ventilation **On/Off** key.

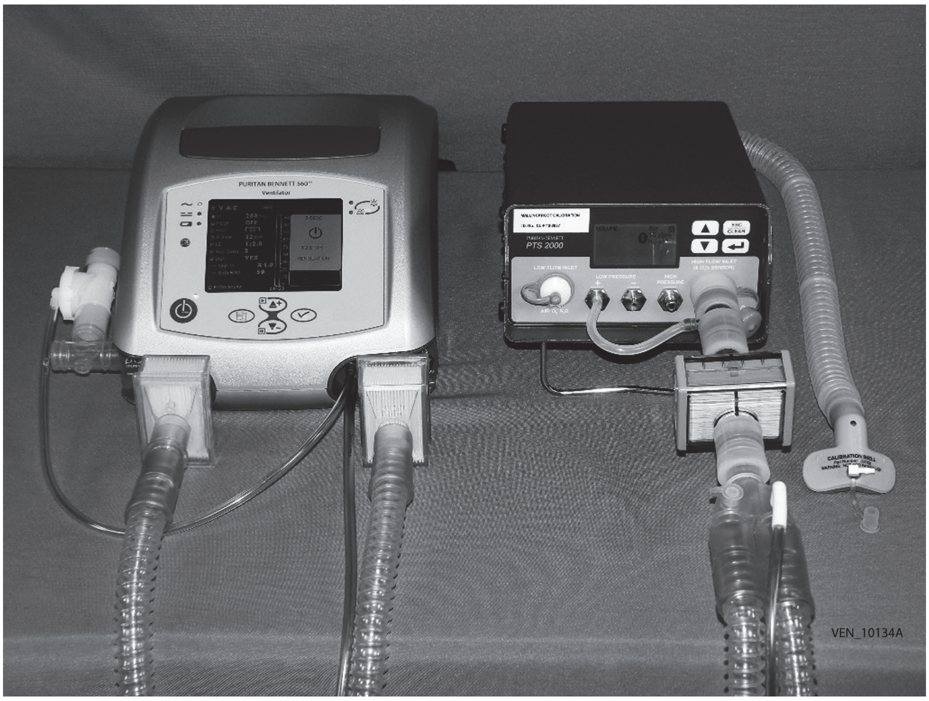
6.9.3 Adult Volume Accuracy

To verify adult volume accuracy:

1. Power on the ventilator in normal ventilation mode on standby.
2. Set the pediatric circuit to **OFF** in the preferences menu.
3. Connect the adult dual-limb patient circuit and exhalation valve to the ventilator.
4. Block the patient circuit wye with a no. 1 stopper.
5. Press **MENU** to access the Alarms menu.
6. Select **VTE**.
7. Press **ENTER** twice so that **OFF** is flashing in the middle column.
8. While **OFF** is flashing, use the **UP** or **DOWN** arrow key to select **YES**.
9. Press **ENTER** to perform exhalation flow calibration.

10. Connect the adult dual-limb patient circuit tubing wye to the PTS 2000 high flow inlet (Figure 6-13).

Figure 6-13. Adult Volume Accuracy Test Setup


PURITAN BENNETT 560™
PTS 2000
CALIBRATION SHELL
VEN_10134A

11. Connect the gold standard tube to the output of the PTS 2000 High Flow outlet.
12. Connect the calibration shell to the other end of the gold standard tube.
13. Set the PTS 2000 to Volume, Air, mL, BTPS, threshold 15 slpm, and Flow-by Tare 3 slpm.

14. With the ventilator in normal ventilation mode on standby, set the listed parameters.
    - Mode: V A/C
    - Vt: 500 mL
    - PEEP: OFF
    - Flow pattern: SQ
    - R-Rate: 10 BPM
    - Insp Time: 1.3s (I:E ratio: 1:3.6 or I/T= 22%)
    - Insp Sens: 5
    - Sigh: OFF
    - PIP Min: 2
    - PIP Max: 60
    - VTE mL Min: OFF
    - VTE mL Max: OFF
    - R tot bpm Max: OFF
15. Start ventilation by pressing the ventilation **On/Off** key.
16. After the ventilator delivers approximately 15 breaths, compare the VtI reading displayed in the alarm menu screen is 440 mL to 560 mL.
17. Verify that the VtI reading displayed on the ventilator's Alarms menu screen is within calculated test limits (PTS 2000 volume measurement ± (8% + 10 mL)).
18. Stop ventilation by using the ventilation **On/Off** key.

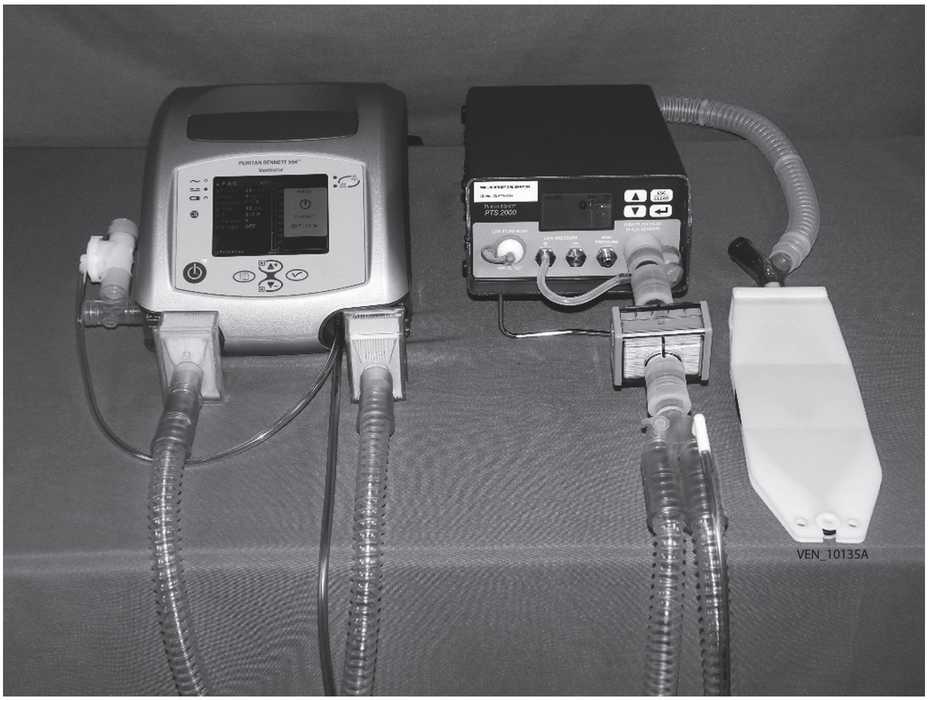
6.9.4 Adult Pressure Accuracy

To verify adult pressure accuracy:

1. Connect the 15-mm ID port of 22-mm OD/15-mm ID adapter to the open end of the gold standard tube.

2. Connect the 1.0-liter hard-sided test lung to the 15-mm ID port of the 22-mm/15-mm adapter (Figure 6-14).

Figure 6-14. Adult Pressure Accuracy Test Setup



3. Set the PTS 2000 set to Low Pressure, cmH_2O.
4. With the ventilator in normal ventilation mode on standby, set the listed parameters.
   - Mode: P A/C
   - Pi: 20 cmH_2O
   - PEEP: OFF
   - Rise time: 1
   - R-Rate: 10 bpm
   - Insp Time: 1.3s (I:E ratio: 1:3.6 or I/T= 22%)
   - Insp Sens: 5
   - Vt target: OFF
   - VTI mL Min: OFF
   - VTI mL Max: OFF
   - VTE mL Min: OFF
   - VTE mL Max: OFF
   - R tot bpm High: OFF

5. After the ventilator delivers approximately 15 breaths, verify the Pi reading displayed in the alarm menu screen is 17 cmH_2O to 23 cmH_2O.
6. Verify that the Pi reading displayed in the ventilator's Alarms menu screen is within calculated test limits (PTS 2000 Low Pressure measurement ± (8.75% + 2.04 cm$H_2$0)).
7. Stop ventilation by using the ventilation **On/Off** key.

6.10 AC/DC/Battery Power Switching Test

WARNING

- **Never perform any of the tests described in this chapter while a patient is connected to the ventilator.**
- **This test requires working with exposed electronics connected to AC power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools from touching electrical components.**

Required equipment:

- external DC power supply capable of at least 2 A output
- digital multimeter
- DC test cable.

To verify AC/DC/Battery power switching:

1. Disconnect AC power from the ventilator.
2. If not already connected, connect the DC test cable to the DC power supply’s positive and negative outputs and External Battery connector on the ventilator’s rear panel

(Figure 6-16, rear view, Figure 6-15, front view).

Figure 6-15. Power Switching Test Setup (front view)

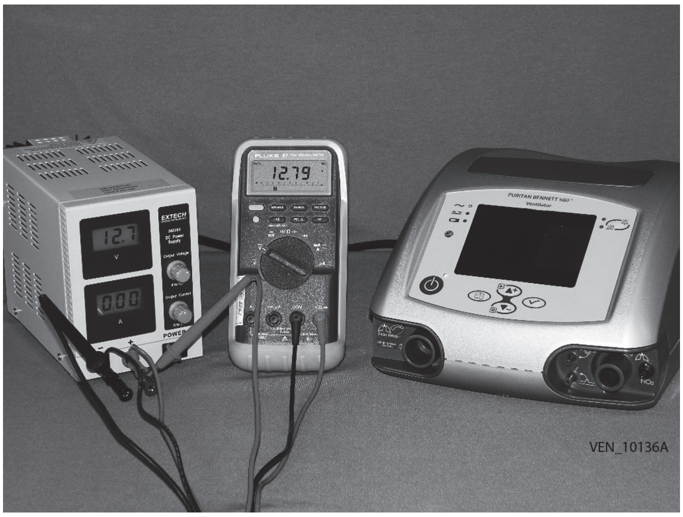
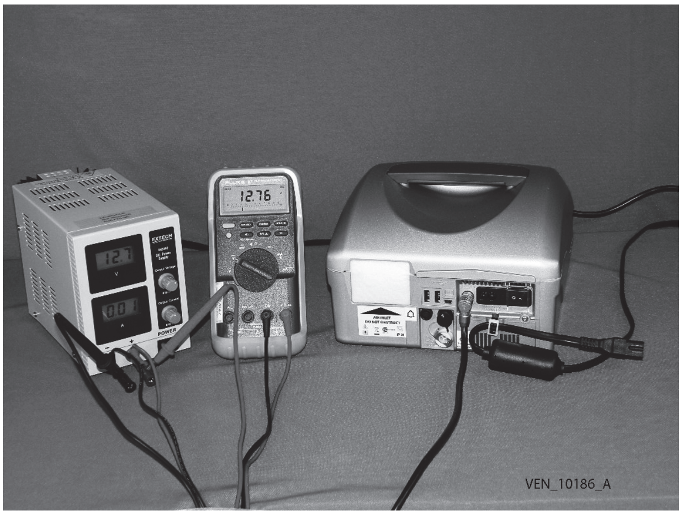


Figure 6-16. Power Switching Test Setup (rear view)



3. Set the external DC power supply voltage to 10.0 V.
4. Use a multimeter to verify the voltage output.
5. Power on the ventilator in normal ventilation mode on standby.
6. Verify the Internal Battery indicator LED lights.

7. Slowly increase the external DC power supply voltage until the ventilator's DC power indicator LED lights.
    a. Verify the ventilator's DC power indicator LED lights when DC power supply voltage measures 10.5 V ± 0.3 V on the digital multimeter.
    b. Verify the ventilator's AC power indicator LED is not lit.
8. Slowly decrease the external DC power supply voltage until the ventilator's internal battery LED lights.
    a. Verify the ventilator's internal battery indicator LED lights when DC power supply voltage is 9.8 V ± 0.3 V (on the digital multimeter).
    b. Verify the ventilator's DC power indicator LED is not lit.
    c. Verify the ventilator shows the message *AC Power Disconnection* and *on Internal Battery*.
9. Press the **ALARM CONTROL** key to pause the alarm.
10. Very slowly increase the external DC power supply voltage until the ventilator's DC power indicator LED lights.
    a. Verify the ventilator's DC power indicator LED lights when DC power supply voltage is 12.8 V ± 0.3 V on the digital multimeter.
    b. Verify the ventilator's internal battery power indicator LED is not lit.
11. Reconnect the AC mains cord to the ventilator.
    a. Verify the ventilator's AC power indicator LED lights.
    b. Verify the ventilator's DC power indicator LED is not lit.

6.11 FiO$_2$ Sensor Calibration

Required equipment:

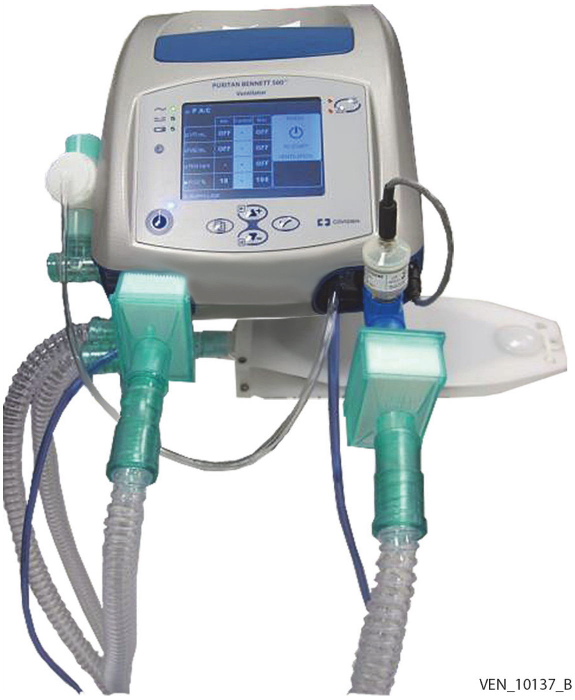
- FiO$_2$ sensor
- silicone coupling
- 2" length of 1/8" ID silicone tubing, plugged at one end
- 1" length of 1/8" ID silicone tubing
- 5" length of 3/16" ID silicone tubing
- calibration shell.

To calibrate FiO$_2$ sensor:

1. Set up the ventilator with FiO$_2$ sensor kit, adult patient circuit with exhalation valve and 1.0-liter hard-sided test lung as shown in Figure 6-17.
2. Power on the ventilator in normal ventilation mode on standby.
3. Press **MENU** to enter the Alarms menu.
4. Turn off all settable alarms except FiO$_2$%.

5. Place the cursor at the FiO_2 position.
6. Press **ENTER** twice to move to the "Current" column.
7. Press the **UP** arrow key to select YES.
8. Press **ENTER** to perform the calibration. If no calibration errors are displayed, then the calibration is successful.

Figure 6-17. FiO_2 Sensor Calibration Setup

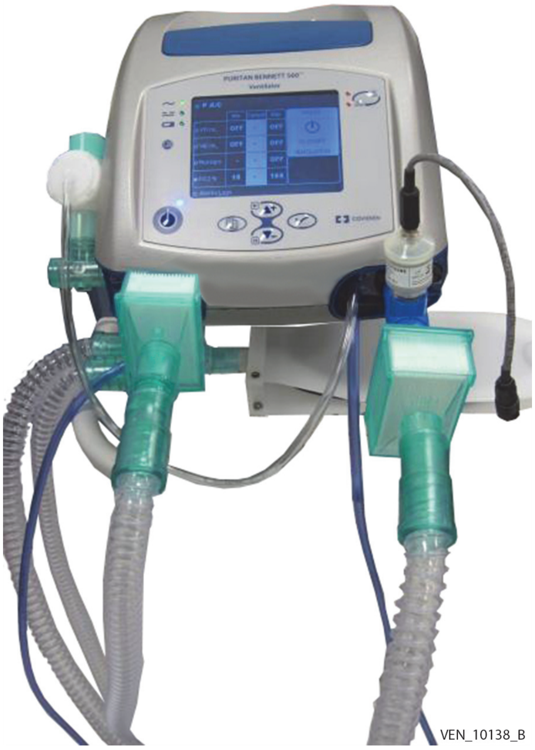


6.12 FiO_2 Sensor Detection Test

1. Set up the ventilator with FiO_2 sensor kit, adult patient circuit with exhalation valve and 1.0-liter hard-sided test lung as shown in Figure 6-17.
2. Power on the ventilator in normal ventilation mode on standby.

3. Set the listed parameters.
    - Ventilation mode: P A/C
    - Pi: 15 cmH_2O
    - PEEP: OFF
    - Rise time: 2
    - R-Rate: 10 bpm
    - Insp time: 1.3s (I:E ratio: 1:3.6 or I/T= 22%)
    - Insp Sens: 5
    - Vt Target: OFF
    - VTI mL Min: OFF
    - VTI mL Max: OFF
    - VTE mL Min: OFF
    - VTE mL Max: OFF
    - R tot bpm High: OFF
4. Start ventilation by pressing ventilation **On/Off** key.
5. Verify the FiO_2 reading is 19% to 23%.
6. Disconnect the FiO_2 sensor cable from the FiO_2 electrical connector on the ventilator's inspiratory conical fitting (Figure 6-18).

Figure 6-18. O_2 Sensor Cable Disconnected



7. Verify the *FiO2 sensor missing* message appears.
8. Set FiO_2 Min and Max alarms to OFF in Alarms menu.
9. Stop ventilation by using the ventilation **On/Off** key.

6.13 Remote Alarm Test

WARNING

- **Never perform any of the tests described in this chapter while a patient is connected to the ventilator.**
- **This test requires working with exposed electronics connected to AC power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools from touching electrical components.**

Required equipment:

- Adult patient circuit and test lung
- Remote alarm test box
- Multimeter

To perform remote alarm test:

1. Set up ventilator with an adult patient circuit with exhalation valve and 1.0-liter test lung.
2. Connect the remote alarm test box cable to the ventilator (Figure 6-19 and Figure 6-20).

Figure 6-19. Remote Alarm Test Setup (front view)

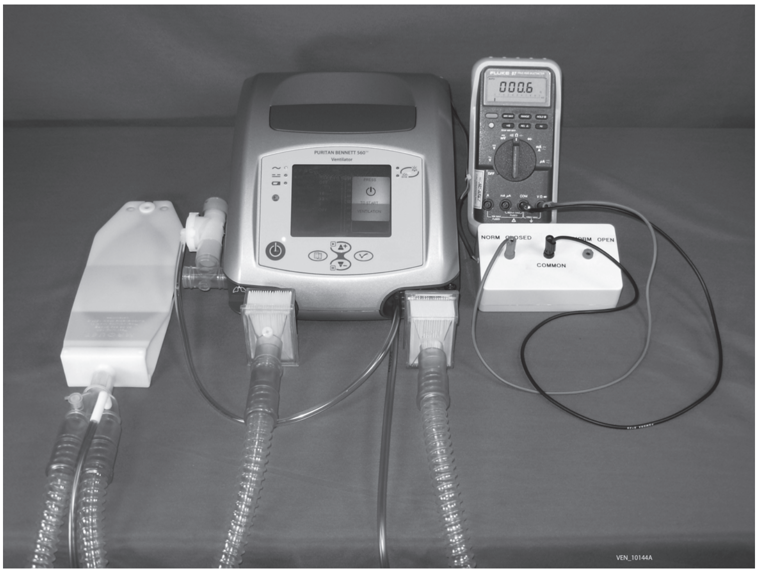
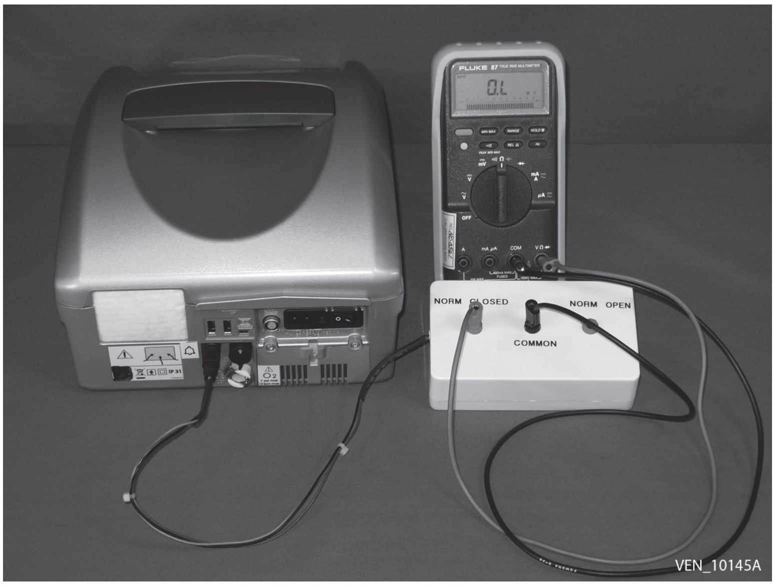

PURITAN BENNETT 560™
Ventilator
PRESS
TO START
VENTILATION
FLUKE 87
000.6
NORM CLOSED
NORM OPEN
COMMON
VEN_10144A

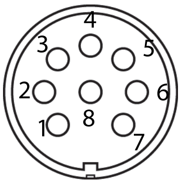
Figure 6-20. Remote Alarm Test Box Connected to Ventilator (rear view)



3. With the ventilator in normal ventilation mode on standby, set the listed parameters:
   - Mode: P A/C
   - Pi: 15 cmH_2O
   - PEEP: OFF
   - Rise time: 2
   - R-Rate: 10 bpm
   - Insp time: 1.3s (I:E ratio: 1:3.6 or I/T= 22%)
   - Insp Sens: 5
   - Vt Target: OFF
   - VTI mL Min: OFF
   - VTI mL Max: OFF
   - VTE mL Min: OFF
   - VTE mL Max: OFF
   - R tot bpm High: OFF
4. Set the Alarm volume in the preferences menu to medium volume.
5. Access the Alarms menu and turn off all settable alarms.
6. Set the multimeter to read ohms.
7. Connect the multimeter negative lead to the common connection on the test box and the positive lead to the normally closed connection.

8. Verify the multimeter reads less than one (1) ohm (closed).
9. Connect the positive lead to the normally open connection and verify the multimeter reads open.
10. Move the multimeter positive lead to the normally closed pin (pin 3), and verify the multimeter reads less than one (1) ohm (closed).

Figure 6-21. Remote Alarm Pin Diagram



1	relay common	5	not used
2	normally open (NO)	6	not used
3	normally closed (NC)	7	not used
4	not used	8	not used

11. Start ventilation by pressing ventilation **On/Off** key.
12. Disconnect the AC power cord from the ventilator.
13. Verify the multimeter reads open.
14. Verify the ventilator AC power indicator LED is OFF and the internal battery indicator LED is lit.
15. Verify the ventilator's medium priority alarm sounds, the yellow alarm LED is flashing, and the AC POWER DISCONNECTION alarm is active.
16. Connect AC power cord.
17. Connect multimeter positive to normally open connection on the test box and the negative multimeter lead to the common connection on the test box.
18. Verify the multimeter reads open.
19. Disconnect AC power cord.
20. Verify the AC power indicator LED is off and internal battery indicator LED is lit.
21. Verify the multimeter reads less than one (1) ohm (closed).
22. Verify a medium-priority alarm sounds, yellow alarm LED flashes, and AC POWER DISCONNECTION alarm is active.
23. Reconnect AC power.
24. Verify the multimeter reads open.
25. Stop ventilation by using the ventilation **On/Off** key.

6.14 Alarms Tests

WARNING

- **Never perform any of the tests described in this chapter while a patient is connected to the ventilator.**
- **This test requires working with exposed electronics connected to AC power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools from touching electrical components.**

Required equipment:

- dual limb patient circuit
- 1.0-liter test lung.

6.14.1 AC Power Disconnection Alarm Test

To test the AC power disconnection alarm:

1. Setup ventilator with adult patient circuit with exhalation valve and 1.0-liter test lung.
2. With ventilator in normal ventilation mode on standby, set the listed parameters.
    - Mode: P A/C
    - Pi: 15 cmH_2O
    - PEEP: OFF
    - Rise time: 2
    - R-Rate: 10 bpm
    - Insp time: 1.3s (I:E ratio: 1:3.6 or I/T= 22%)
    - Insp Sens: 5
    - Vt Target: OFF
    - VTI mL Min: OFF
    - VTI mL Max: OFF
    - VTE mL Min: OFF
    - VTE mL Max: OFF
    - R tot bpm High: OFF
3. Access Alarms menu and turn off all settable alarms.
4. Start ventilation by pressing ventilation **On/Off** key.
5. Unplug the AC power cord from the ventilator.
6. Verify a medium priority alarm sounds.
7. Verify an amber alarm LED flashes continuously.
8. Verify *AC POWER DISCONNECTION* message appears in the alarm display area.
9. Reconnect the AC power cord to the ventilator.
10. Verify *AC POWER DISCONNECTION* alarm automatically resets.

6.14.2 Patient Disconnect Alarm Test

To test the patient disconnect alarm:

1. With the device still in ventilation mode from the previous test, disconnect the inspiratory filter at the *To Patient* port.
    a. Verify the High Priority alarm sounds within 15 seconds.
    b. Verify the red High Priority LED flashes.
    c. Verify the *LOW PRESSURE DISCONNECT* *IF PERSISTS RESTART/SRVC* messages appear in the alarm display area.
2. Reconnect the inspiratory filter to the *To Patient* port.
3. Verify the alarm auto-resets.
4. Stop ventilation by using the ventilation **On/Off** key.

6.14.3 Power Off While Ventilating Test

To power off while ventilating test:

1. Setup the ventilator with adult patient circuit, exhalation valve, and 1.0-liter hard-sided test lung.
2. With ventilator in normal ventilation mode on standby, set the listed parameters.
    - Ventilation mode: P A/C
    - Pi: 15 cmH_2O
    - PEEP: OFF
    - Rise time: 2
    - R-Rate: 10 bpm
    - Insp time: 1.3s (I:E ratio: 1:3.6 or I/T= 22%)
    - Insp Sens: 5
    - Vt Target: OFF
    - VTI mL Min: OFF
    - VTI mL Max: OFF
    - VTE mL Min: OFF
    - VTE mL Max: OFF
    - R tot bpm High: OFF
3. Start ventilation by using the ventilation **On/Off** key.
4. While ventilating, power off the ventilator using the power switch.
    a. Verify the VHP alarm sounds continuously for a minimum of 120 seconds.
    b. Verify ventilation stops (no LED or alarm message appears on the display)

5. After 120 seconds has elapsed, press the **ALARM CONTROL** key once to pause the alarm.
6. Power on the ventilator using the power switch.
7. Verify the ventilator immediately resumes ventilation.
8. Stop ventilation by using the ventilation **On/Off** key.

6.14.4 USB Ports Test

Required equipment:

USB memory device (128 MB minimum memory requirement and formatted in the 32-bit file format)

To test the USB ports:

1. With ventilator in normal ventilation mode on standby, connect a USB memory device to one of the USB type A ports at the rear of the ventilator.
2. Verify the ventilator annunciates two short beeps when the USB device is connected.
3. If the ventilator does not recognize the USB memory device, try another USB memory device.
4. Verify the ventilator screen displays the **USB Key Management** menu.
5. Verify the *Wait* message appears.
6. After the *Wait* message disappears, remove the USB memory device from the USB port.
7. Verify the ventilator annunciates two short beeps with disconnection of the USB device.
8. Insert the USB device into the other USB port and repeat steps 2 -7.

6.15 Verify Default Settings

WARNING

- **Never perform any of the tests described in this chapter while a patient is connected to the ventilator.**
- **This test requires working with exposed electronics connected to AC power. In order to prevent injury or damage to the ventilator, use extreme caution in keeping hands and tools from touching electrical components.**

To verify default ventilator settings

1. With ventilator in normal ventilation mode on standby, set the ventilator parameters, alarms, and preferences according to Table 6-4, Table 6-5, and Table 6-6.
2. Verify the time and date are current.

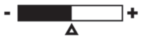
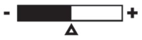
Table 6-4. Default Ventilator Settings

Parameter	Setting
Mode	P A/C
Pi	15 cmH_2O
PEEP	OFF
Rise Time	2
Respiratory rate	10
Insp Time or I:E	1.3s (I:E ratio: 1:3.6 or I/T= 22%)
Insp Sens	2
Vt Target	OFF

Table 6-5. Default alarm settings

Alarm	Setting
VTI	Min 300 mL; Max 2000 mL
VTE	Min 300 mL; Max1000 mL
Leak (if applicable)	High OFF
Rtot	High OFF

Table 6-6. Default preferences

Preference	Setting
Backlight	YES
Contrast	
Alarm Volume	
Key Sound	Accept tone
Waveforms Display	YES
Pediatric Circuit	NO

6.16 Clear Faults

Note:

Clearing the fault log also clears the alarm log and the event log. Any faults must be addressed prior to completing Performance Verification.

1. Press and hold the **ALARM CONTROL** key while simultaneously using the main power switch to power on the ventilator to enter **SETUP** mode.
2. Use the **UP** and **DOWN** arrow keys to place the cursor at the *Maintenance* position.

3. Press **ENTER**. The cursor moves to the *Faults Check* position.
4. Press and hold the **ALARM CONTROL** key until a long beep sounds.
5. With the cursor at the *Faults Check* position, press **ENTER** to display the fault log.
6. Verify *NO DATA* appears on the FAULTS screen.
7. Press **ENTER** to exit the Faults Check function.

6.17 Reset Patient Hours

Note:

Resetting the patient hours will also reset the trend data stored in the device memory in preparation for a new patient.

1. Press and hold the **ALARM CONTROL** key while simultaneously using the main power switch to power on the ventilator to enter **SETUP** mode.
2. Use the **UP** and **DOWN** arrow keys to place the cursor at the *Patient Hours* position.
3. Press **ENTER**. The cursor moves to the *Reset Hours* position.
4. Press **ENTER** so *OFF* flashes.
5. Press the **UP** and **DOWN** arrow keys to change the message to *YES*.
6. Press **ENTER**.
7. Verify a long beep sounds and the patient counter display resets to *00000 h and 00 min*.
8. Press the **UP** and **DOWN** arrow keys to exit the Reset Patient Hours function.

7 Parts List

This chapter identifies the repair parts available for the Puritan Bennett™ 560 Ventilator.

7.1 How to Use the Parts Lists

This chapter shows various views of the entire ventilator system and its components. To use the parts lists, refer to the appropriate drawing for the part(s) you need to order. The following assembly drawings are provided:

- major system components
- electrical system components
- pneumatic system components
- turbine assembly components
- labels.

The corresponding table for each drawing lists the item number, part number, quantity required, and part description. If a part number does not appear, it is because it cannot be ordered individually. You must order the assembly, instead. If part numbers are listed, even though they may be included in an assembly, then these may be ordered individually.

Abbreviations used in this chapter are listed in Table 7-1.

Table 7-1. Abbreviations

Abbreviation	Meaning
HEXALOBE	Hexalobular fastener (Torx®)
ID	Inside Diameter
OD	Outside Diameter
PCBA	Printed Circuit Board Assembly

7.2 Major System Components

Table 7-2. Major System Component Part Numbers

Item no. Figure 7-1	**Part no.**	**Qty**	**Description**
1	10046895	1	Keypad (part of upper housing assembly)
2	3823200	1	Handle (part of upper housing assembly)
3	10049509	1	Upper housing assembly (includes, keypad, handle with screws, and labels)
--	not available separately order upper housing assembly	--	Upper housing (part of upper housing assembly)
4	10046894 (label kit)	1	Label, pneumatic cable diagram (part of upper housing assembly)
5	2960600	2	Screw, HEXALOBE, M4 x 10, galvanized steel countersunk (2 required for handle; 5 required for housings)
6	2966100	4	Galvanized steel TCB screw HEXALOBE M3 x 5
7	3812500	1	Shielding plate motor harness
8	10053276	1	Turbine control PCBA
9	10028768		Turbine
10	3812400	4	Hexagonal spacer M/F M3 LG5
11	2970800	2	Exhalation solenoid valve mounting screw
12	10028753	1	LCD panel
13	10025114	4	Screw, M3 x 8 (LCD panel mounting screws)
14	10023294	4	LCD panel spacer
15	10025115	4	LCD panel washer
16	2957500	3	Galvanized steel TCB screw HEXALOBE D3.5 x 8
17	10053275	1	CPU PCBA
18	3818699	1	Exhalation solenoid valve
19	2699400	1	Truarc retaining ring (holds captive knob) (part of lower housing assembly)
20	10046894 (label kit)	1	ESD label (part of lower housing assembly)
21	10028771	1	Filter, inlet air (pack of 6)
22	2399700	4	Adhesive collar (cable guides) (part of lower housing assembly)

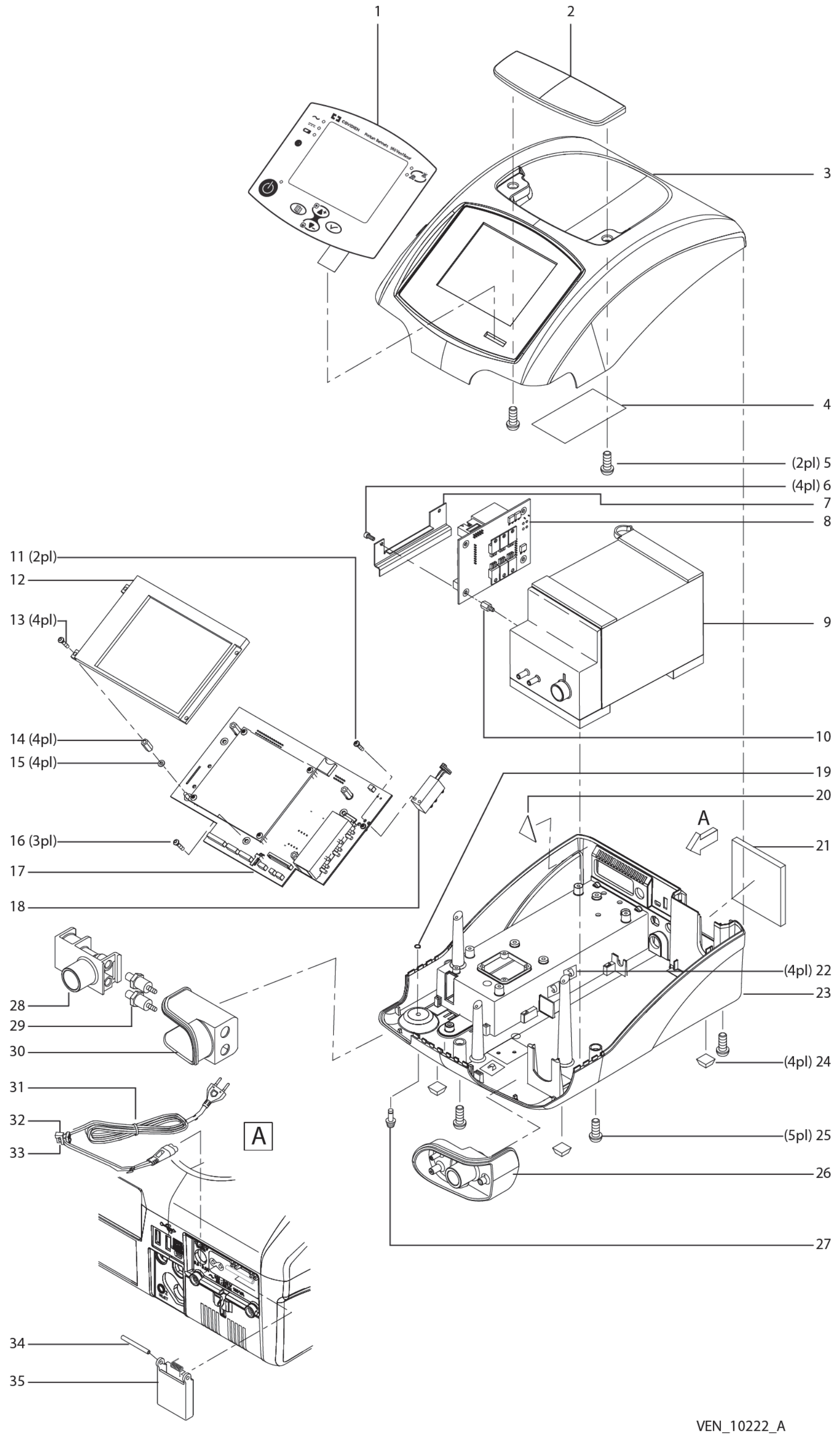
Table 7-2. Major System Component Part Numbers (continued)

Item no. Figure 7-1	Part no.	Qty	Description
23	10049508 10005243	1 1	Lower housing assembly (compatible with original remote alarm harness 10028752) Lower housing assembly (compatible with updated remote alarm harness 10005246)
24	2961500	4	Adhesive feet 12.7 x 12.7 (part of lower housing assembly)
25	2960600	5	Screw, HEXALOBE, M4 x 10, galvanized steel countersunk (2 required for handle; 5 required for housings)
26	10080325	1	Inspiratory conical fitting assembly (with labels
27	3809700	1	Knurled captive knob (part of lower housing assembly
28	10046892	1	Exhalation block assembly (with labels)
--	10046803	--	Exhalation block assembly (with labels, 10-pack)
29	10029945	2	Baffle conduit, fluted (exhalation connectors)
30	10028747	1	Exhalation conical fitting support
31	See Table 2-1 for country-specific part numbers	1	Power cable
32	not available separately: order power cord assembly	1	Cable grip, 6.6 x 4.3 (part of power cord assembly)
33	not available separately: order power cord assembly --	1	Clip, cable grip, 6.6 x 4.3 (part of power cord assembly)
34	not available separately: order switch cover assembly 10028765	1	Cylindrical pin 2 x 28 stainless steel (part of switch cover assembly)
35	not available separately: order switch cover assembly10028765	1	Switch cover (part of switch cover assembly)

Table 7-2. Major System Component Part Numbers (continued)

Item no. **Figure 7-1**	**Part no.**	**Qty**	**Description**
--	not available separately: order switch cover assembly 10028765	1	Cover spring (part of switch cover assembly)
--	10046894 (label kit)	1	Label, valve connection (see Figure 7-7, item 1)
--	10046894 (label kit)	1	Label, Exhalation single patient use (see Figure 7-7, item 2)
--	10028765	1	Switch cover assembly
--	10046894 (label kit)	1	Label O_2/RA (See Figure 7-5 Items 5-6
--	10046894 (label kit	1	Label, FiO_2 (See Figure 7-5, item 2)
--	10046894 (label kit	1	Label, Exh valve/proximal pressure see Figure 7-5, item 2

Figure 7-1. Major System Components


1
2
3
4
(2pl) 5
(4pl) 6
7
8
11 (2pl)
12
13 (4pl)
9
14 (4pl)
15 (4pl)
10
19
20
A
16 (3pl)
21
17
18
(4pl) 22
28
23
29
30
(4pl) 24
31
32
A
33
(5pl) 25
26
27
34
35
VEN_10222_A

7.3 Electrical System Components

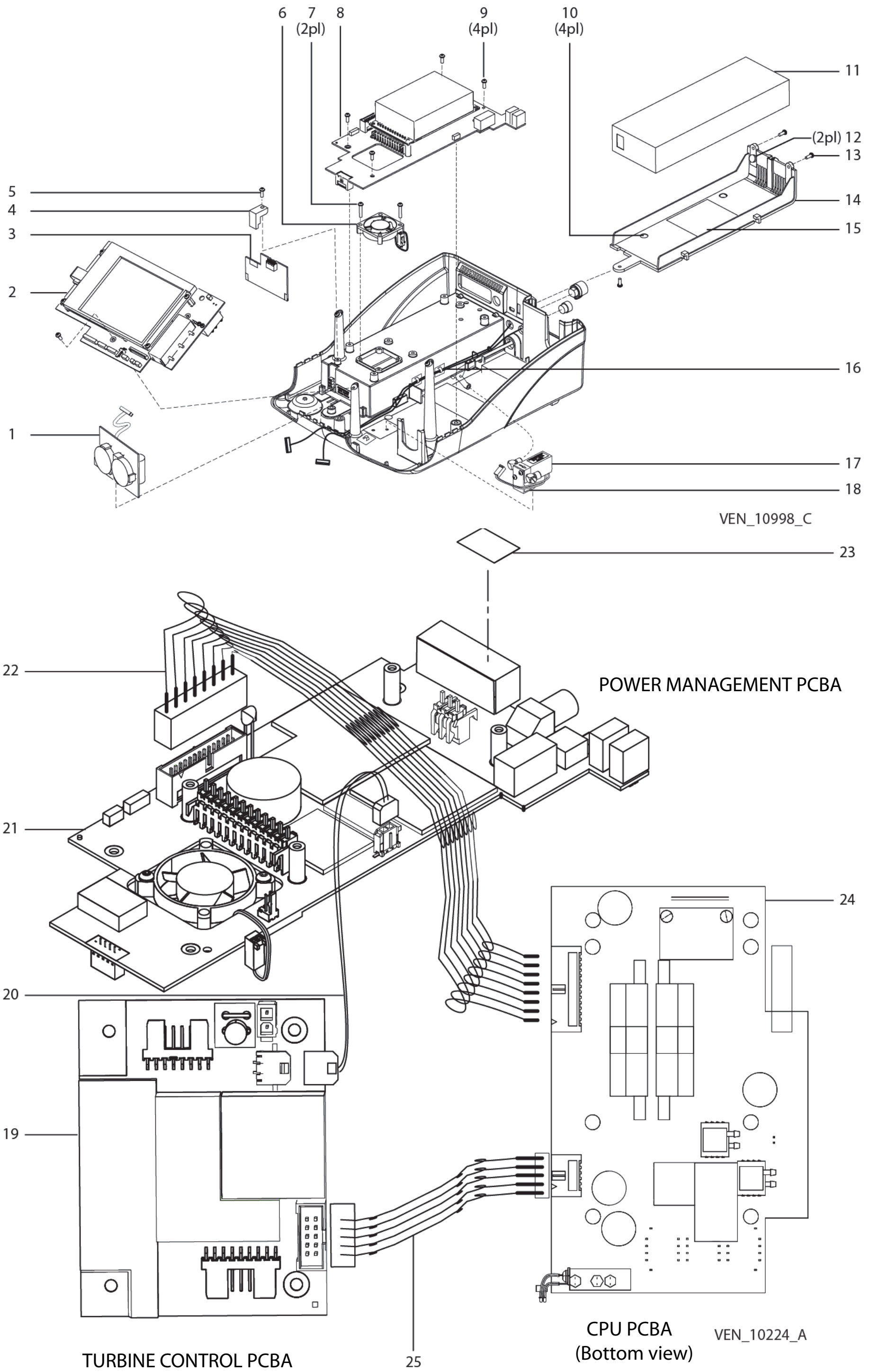
Table 7-3. Electrical System Component Part Numbers

Item no. Figure 7-2	**Part no.**	**Quantity**	**Description**
1	10108395	1	Buzzer PCBA
2	10053275	1	CPU PCBA (includes LCD)
3	10028757	1	Battery connection PCBA
4	3810200	1	Stop, Battery connection PCBA
5	2957500	1	Zinc plated steel TCB screw HEXALOBE D3.5 x 8 (fastener for battery connection PCBA)
6	10028754	1	Fan with cable
7	10000265	2	Zinc plated steel TCB screw HEXALOBE D3.0 x 25
8	10053277	1	Power management PCBA
9	2957500	4	Zinc plated steel TCB screw HEXALOBE D3.5 x 8
10	2966300	6	Adhesive stop, diameter 8 mm, thickness 2.2 mm (part of battery cover assembly)
11	10087047	1	Li- ion battery, assembly 4.8 Ah capacity (with labels) Requires minimum revision power management software AL020002
12	2973900	2	Silicone stop (part of battery cover assembly)
13	2960100	3	Screw, HEXALOBE D3 x 8, galvanized steel TCB (part of battery cover assembly)
14	10054177	1	Battery cover assembly
15	1006894 (label kit)	1	Battery assembly label (part of battery cover assembly)
16	10028752 10005246 10000914	1	Original remote alarm harness Updated remote alarm harness Remote alarm cable (RAII)
17	10028763	1	2-way solenoid valve, O_2
18	3827900	1	Square support bracket, O_2 valve
19	10053276	1	Turbine control PCBA
20	10028751	1	Power supply/turbine harness
21	10053277	1	Power management PCBA
22	10053278	1	CPU/Power supply harness
23	1006894 (label kit)	1	Mains warning label
24	10053275	1	CPU PCBA (includes LCD)
25	--	1	CPU/turbine harness (part of 10053276)

Table 7-3. Electrical System Component Part Numbers (continued)

Item no. Figure 7-2	Part no.	Quantity	Description
-	10046894 (label kit)	1	Label O_2/RA (Two-piece label; O_2) (part of battery cover assembly) See Figure 7-5, Items 5 & 6
-	10025113	1	Double sided tape (not shown)
-	2980100	1	Wire ferrite (not shown)
-	10022884	1	Battery, 3V, 35 mAh

Figure 7-2. Major Electrical Assemblies


6
7
(2pl)
8
9
(4pl)
10
(4pl)
11
(2pl) 12
13
14
15
5
4
3
2
16
1
17
18
VEN_10998_C
23
22
POWER MANAGEMENT PCBA
21
24
20
19
TURBINE CONTROL PCBA
25
CPU PCBA
(Bottom view)
VEN_10224_A

7.4 Pneumatic System Components

Table 7-4. Pneumatic System Component Part Numbers

Item no. Figure 7-3	Part no.	Qty	Description
1	2969600	see Figure 7-3 for specific lengths	Silicone tubing, 1.6 mm ID x 4.8 mm OD
2	2970400	1	Tee connector, 2.4, plastic
3	2969600	see Figure 7-3 for specific lengths	Silicone tubing, 1.6 mm ID x 4.8 mm OD
4	2969600	see Figure 7-3 for specific lengths	Silicone tubing, 1.6 mm ID x 4.8 mm OD
5	2970300	1	Straight connector, 2.4 x 3.2 plastic
6	2969500	see Figure 7-3 for specific lengths	Silicone tubing diameter 3.2 mm ID x 6.4 mm OD
7	2969500	see Figure 7-3 for specific lengths	Silicone tubing diameter 3.2 mm ID x 6.4 mm OD
8	2963800	2	Galvanized steel countersunk screw HEXALOBE M3 x 8 (O_2 valve bracket to lower housing)
9	3827900	1	Square support bracket, O_2 valve
10	2100500	2	Tie-wrap (for O_2 sol valve outlet, turbine inlet
11	2970800	2	Galvanized steel TCB screw HEXALOBE D3 x 6 (bracket screws)
12	10028763	1	2-way solenoid valve (O_2)
13	2962799	1	Oxygen inlet connector
14	2962600	1	O_2 female connector with valve
15	10038115	1	Turbine/inspiratory port connection tube
16	2966800	see Figure 7-3 for specific length	Polyamide tubing 6 mm x 4 mm (0.2)

Table 7-4. Pneumatic System Component Part Numbers (continued)

Item no. Figure 7-3	Part no.	Qty	Description
17-20	2969500	see Figure 7-3 for specific lengths	Silicone tubing diameter 3.2 mm ID x 6.4 mm OD
21-22	2969600	see Figure 7-3 for specific lengths	Silicone tubing, 1.6 mm ID x 4.8 mm OD

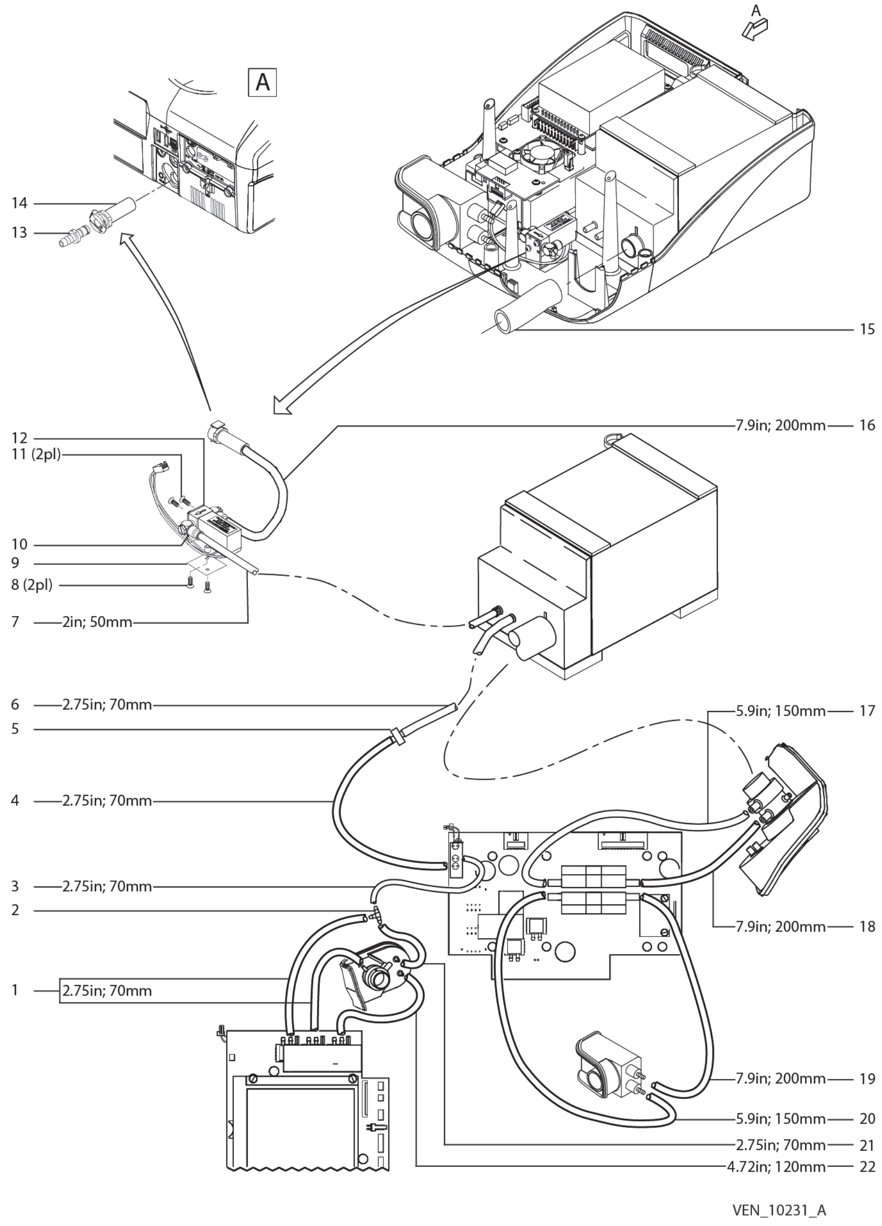


Figure 7-3. Pneumatic Components and Connection Diagram

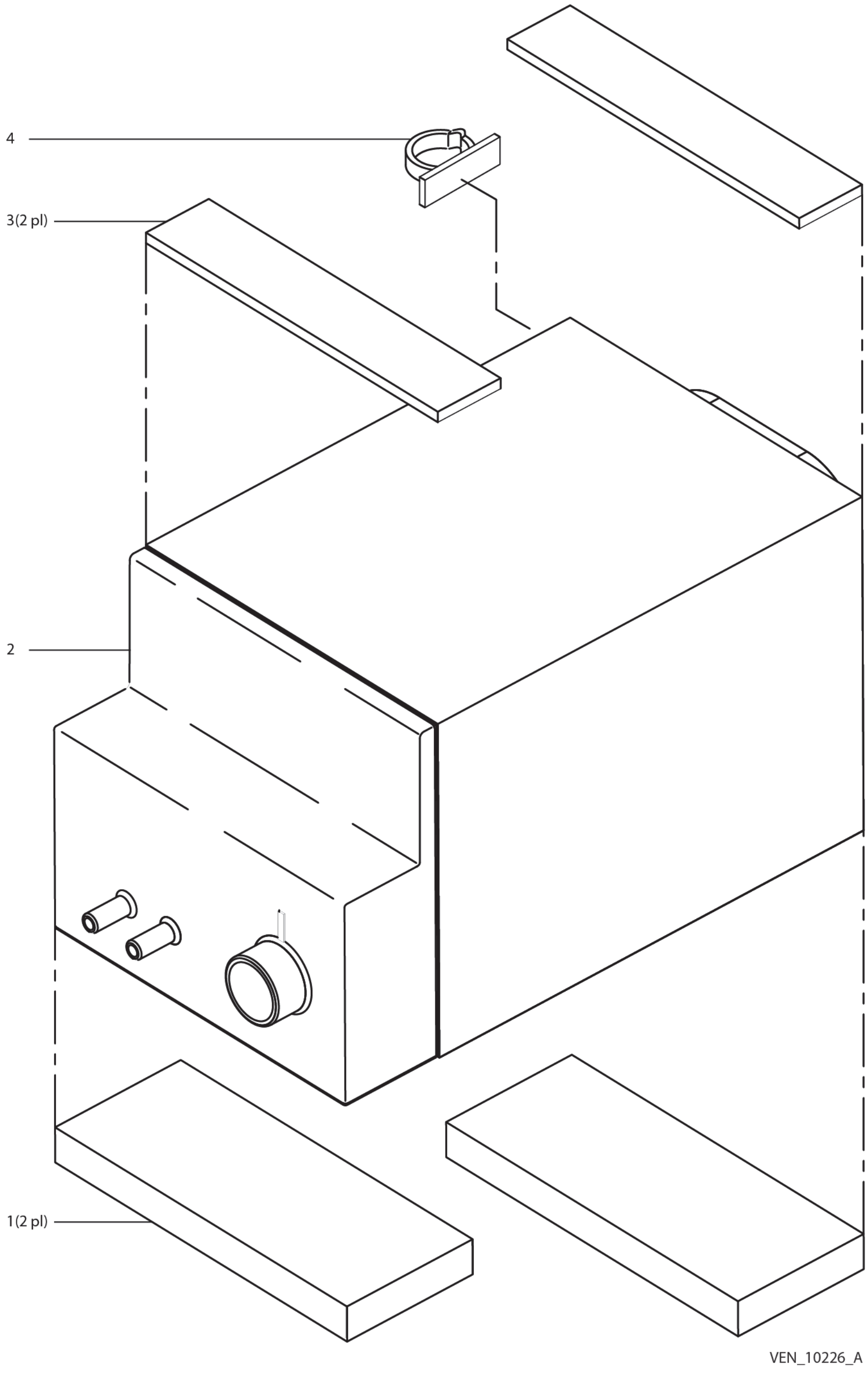
A
A
14
13
15
12
11 (2pl)
7.9in; 200mm 16
10
9
8 (2pl)
7 2in; 50mm
6 2.75in; 70mm
5
5.9in; 150mm 17
4 2.75in; 70mm
3 2.75in; 70mm
2
7.9in; 200mm 18
1 2.75in; 70mm
7.9in; 200mm 19
5.9in; 150mm 20
2.75in; 70mm 21
4.72in; 120mm 22
VEN_10231_A

7.5 Turbine Assembly Components

Table 7-5. Turbine Assembly Component Part Numbers

Item no. Figure 7-4	Part no.	Qty	Description
1	2391200	2	Black foam - width 40 mm; thickness 10 mm
2	10028768	1	Turbine
3	2877500	2	Neoprene adhesive strip
4	2971600	1	Adjustable adhesive collar (toroid clamp)

Figure 7-4. Turbine Assembly Drawing


4
3(2 pl)
2
1(2 pl)
VEN_10226_A

7.6 Label Kit

Table 7-6 lists the contents of the complete label kit and the general locations of each label. The subsequent tables break the kit down by location and correspond to the illustrations on their respective facing pages.

Table 7-6. Label Kit, P/N10046894

Description	Location
Label, Air inlet	Lower housing, back of ventilator
Label, Battery assembly	Inside battery cover (see Item 15)
Label, ESD	Inside ventilator, lower housing (see Item 35)
Label O_2/RA (remote alarm portion)	Lower housing, back of ventilator
Label O_2/RA(O_2 portion)	Battery cover
Label, Pneumatic cabling	Inside ventilator, upper housing (see Item 4)
Label, exhalation valve proximal pressure	Front of ventilator, on inspiratory block (See Figure 7-5 Item 3)
Label, exhalation single use	On exhalation block (See Figure 7-5 Item 1)
Label, identification	Bottom of ventilator (See Figure 7-6 Item 1)
Label, valve connection	Exhalation block (See Figure 7-7 Item 1)
Label, exhalation, single patient use	Exhalation block (see Figure 7-7 Item 2)
Label, polyester blank (serial number window)	Under product ID label

Figure 7-5. Front and Back Panel Labels

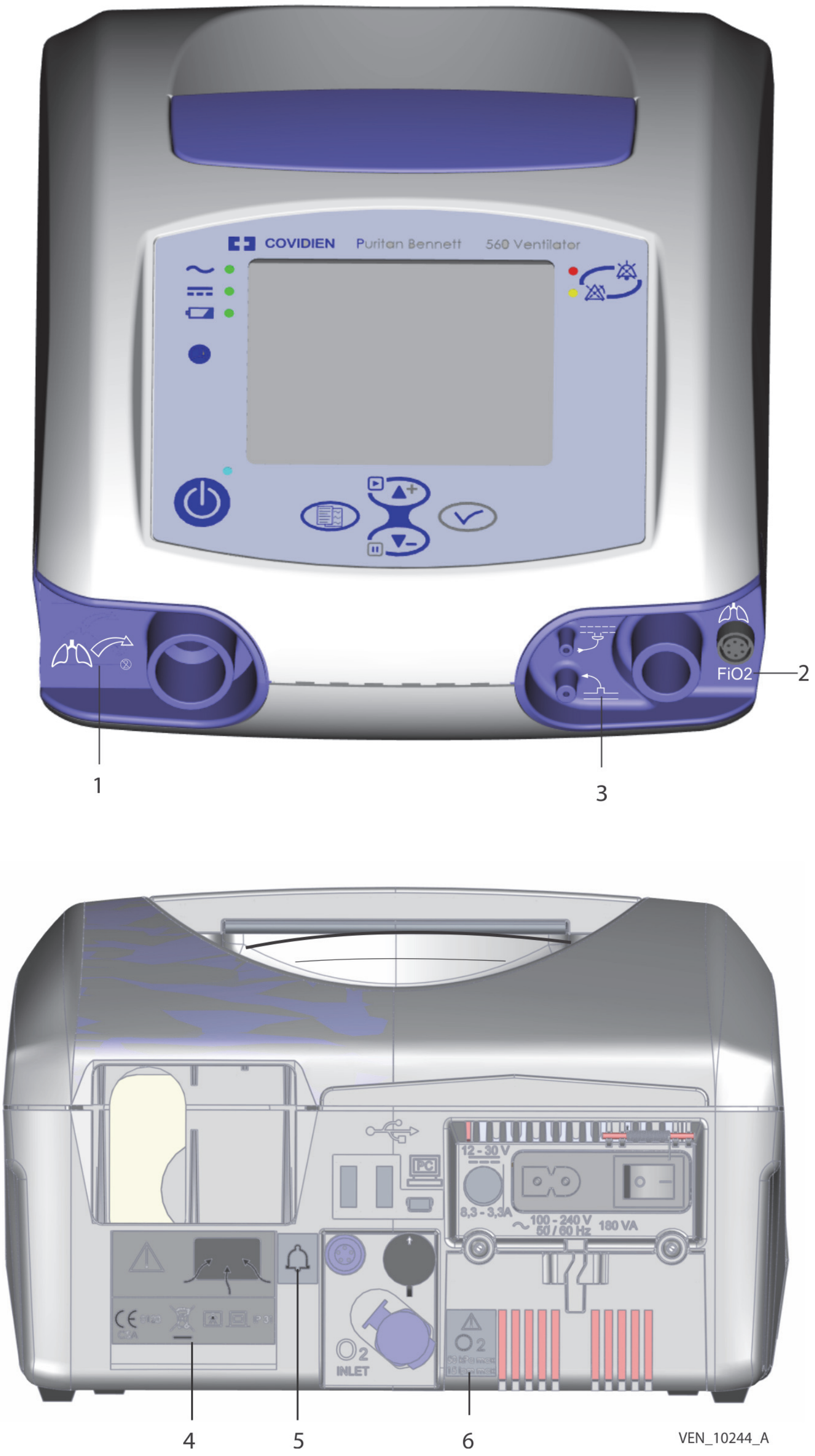

COVIDIEN
Puritan Bennett
560 Ventilator
FiO2
2
1
3
12 - 30 V
8,3 - 3,3A
100 - 240 V
50 / 60 Hz
180 VA
O2
INLET
4
5
6
VEN_10244_A

Table 7-7. Front and Back Labels

Item no. Figure 7-5	Part no.	Qty	Description
--	10046894	--	Label kit
1	--	1	Label, Exhalation single patient use
2	--	1	Label, FiO_2
3	--	1	Label, exhalation valve/proximal pressure
4	--	1	Label, Air inlet
5	--	1	Label O_2/RA (remote alarm portion)
6	--	1	Label O_2/RA (O_2 portion)

Figure 7-6. Bottom Panel Label

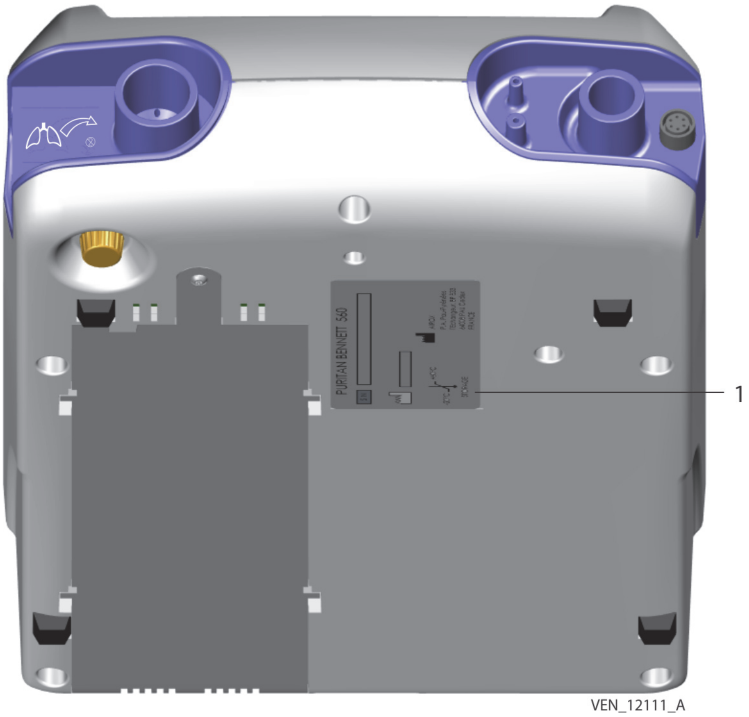

PURITAN BENNETT 560
1
VEN_12111_A

Table 7-8. Bottom Panel Label

Item no. Figure 7-6	Part no.	Qty.	Description
1	label kit	1	Product identification label

Figure 7-7. Left Side Panel Labels

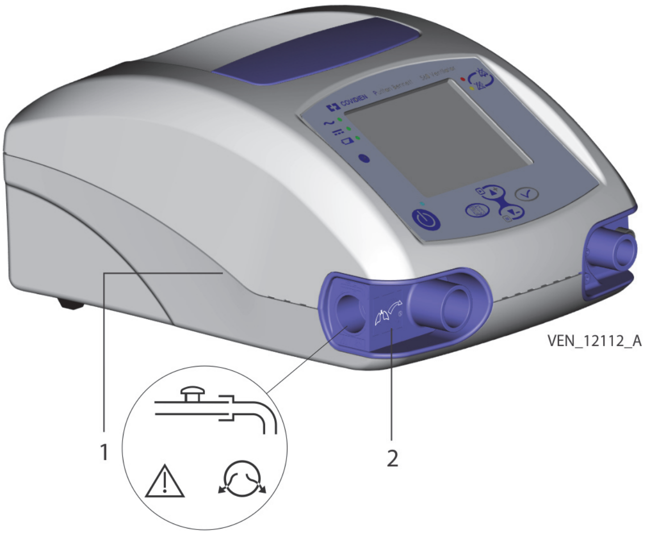


Table 7-9. Left Side Panel Labels

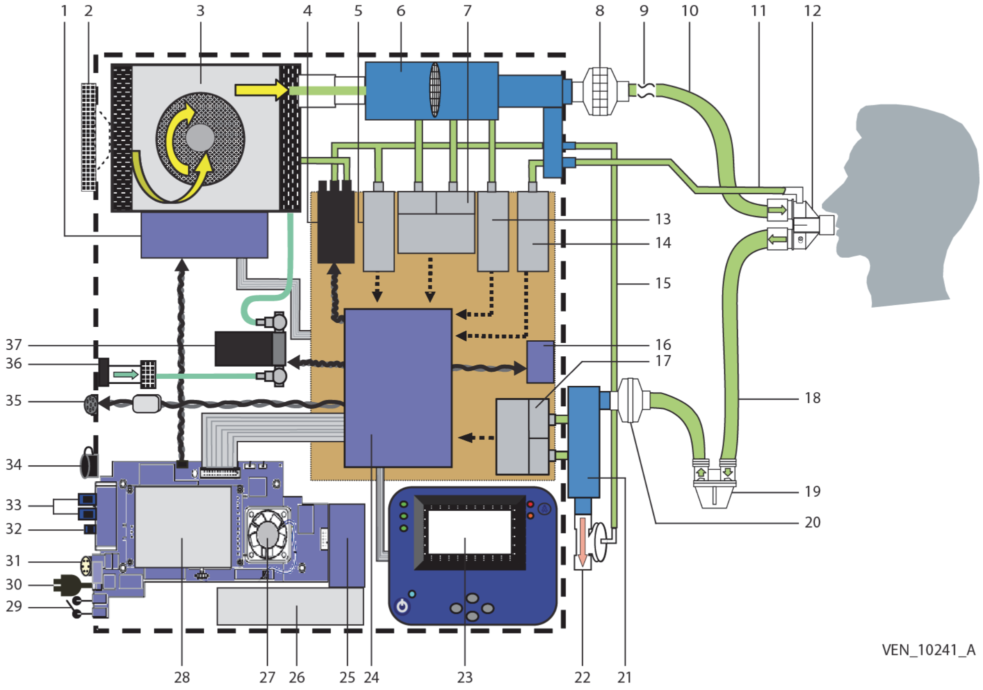
Item no. Figure 7-7	Part no.	Qty	Description
Item no.	**Part no.**	**Qty**	**Description**
1	--	1	Label, valve connection
2	--	1	Label, exhalation, single patient use

Appendix A

A.1 Overview

This appendix contains diagrams for the Puritan Bennett™ 560 Ventilator referenced in Chapter 3.

Figure A-1. Pneumatic Block Diagram


1
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22
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28
29
30
31
32
33
34
35
36
37
VEN_10241_A

1	Turbine control PCBA
2	Inlet air filter
3	Turbine
4	Exhalation solenoid valve
5	Exhalation valve pressure sensor
6	Inspiratory block
7	Inspiratory flow sensor
8	Inspiratory bacteria filter
9	Not shown with humidifier, nebulizer, or additional water traps
10	Inspiratory tubing
11	Proximal pressure tube
12	Patient wye
13	Inspiratory pressure sensor
14	Proximal pressure sensor
15	Exhalation valve pilot tube
16	Buzzer PCBA
17	Exhalation flow sensor
18	Exhalation tubing
19	Water trap
20	Exhalation bacteria filter
21	Exhalation block
22	Exhalation valve
23	Display
24	CPU PCBA
25	Battery connection PCBA
26	Internal battery
27	Cooling fan
28	Power supply (located above power management PCBA)
29	Power switch
30	AC input
31	DC input
32	PC port
33	Type A USB ports (2)
34	SpO$_2$ port (not used)
35	Nurse call port
36	Low pressure O$_2$ inlet
37	O$_2$ solenoid valve

Figure A-2. Power Management PCBA Block Diagram

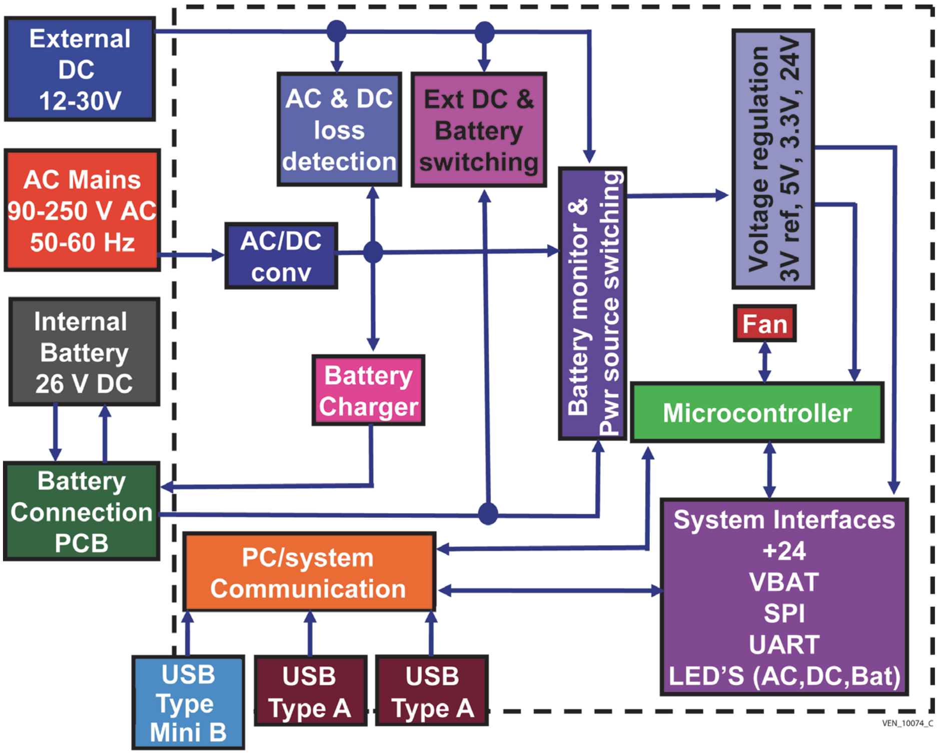
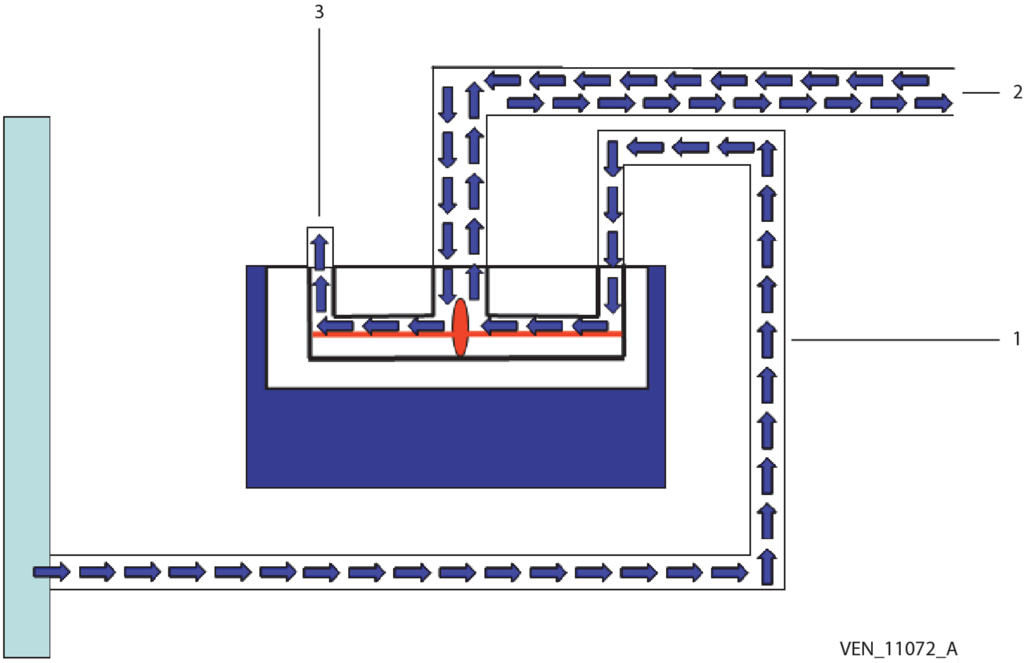

External DC 12-30V
AC Mains 90-250 V AC 50-60 Hz
Internal Battery 26 V DC
Battery Connection PCB
AC & DC loss detection
Ext DC & Battery switching
AC/DC conv
Battery Charger
Battery monitor & Pwr source switching
Voltage regulation 3V ref, 5V, 3.3V, 24V
Fan
Microcontroller
System Interfaces +24 VBAT SPI UART LED'S (AC,DC,Bat)
PC/system Communication
USB Type Mini B
USB Type A
USB Type A
VEN_10074_C

Figure A-3. Exhalation Solenoid Valve During Inspiration and Exhalation



1 Turbine flow applied to port 1

2 To patient circuit exhalation valve and exhalation pressure transducer

3 Port 3 vents to atmosphere

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Part No. 10039435 Rev F 2017-05

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